The Australian Geographer

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Edited by
Dorothy R. Taylor and David G. Stead.

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Journal of The Geographical Society of New South Wales
17 BLIGH STREET, SYDNEY

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THE GEOGRAPHICAL SOCIETY
OF NEW SOUTH WALES
17 BLIGH STREET, SYDNEY

NOTICES.

The Honorary Editors will welcome suitable contributions to *The Australian Geographer*, particularly manuscript of lectures and papers given before the Monthly Meetings of the Society, which must be given precedence. In preparing their papers members will greatly facilitate the work of the editors if they will, as far as possible, have them typed (open spacing), thoroughly revised and corrected (especially as regards technical nomenclature), and furnish therewith a brief summary.

MEETINGS of the GEOGRAPHICAL SOCIETY OF NEW SOUTH WALES are held, unless otherwise notified, on the second Tuesday in each month. In addition to the presentation of lectures and papers, members are reminded that exhibits and notes of field observations are welcomed. Visitors may be brought to the meetings.

Annual Subscription.—Ordinary Members, 10/- (5/- for latter half of year). **Associate Members** (University Undergraduates and College Students), 5/-.

(Form of Application for Membership on last page.)

The Australian Geographer

Vol. 1. AUGUST, 1928. Part 1.

EDITORIAL NOTE

IN launching *The Australian Geographer*—which is to be regarded as the official Journal of the Geographical Society of New South Wales—the editors deem it an opportune moment to say something, both of the objects of the organisation (and of this, its organ) and the circumstances surrounding its inception.

For a number of years those interested in geographical matters have felt that there is room for a society devoted to this subject (or, rather, to this congeries of subjects) in the largest city of Australia. Such societies exist in Adelaide and Brisbane—much smaller cities—and, indeed, in Queensland there are also eleven branch societies in smaller towns of the State. Sir Edgeworth David has pointed out that modern Geography may be described as the best guide to nation-planning.

There is a further reason why a society devoted to geographical study is desirable, and should flourish, in New South Wales: There are now many young teachers and students who have passed through the Department of Geography at the University of Sydney in the course of the last six years who have, it is believed, acquired a real knowledge of modern scientific geography in which *principles and causes, rather than places and statistics*, are chiefly studied. We might hope for valuable research from such a group of potential members. In a relatively new land like Australia, there is, however, a very large amount of purely descriptive work to be done before the more scientific correlations can be deduced—and here is an enormous field for valuable work.

In a preliminary notice issued by Professor Griffith Taylor during April of last year, the foregoing was pointed out, and a tentative scheme for the formation of a Geographical Society here was elaborated. Apart from the students of Geography and General Science who might be attracted to such an organisation, it was hoped that many citizens not specifically interested in Geography as a science would feel that the society was worthy of their attendance and support. Our studies in Geography are all the more necessary, because Australia, a nation almost wholly British in origin, is settling a land which in no respect resembles the homeland; and, indeed, for the most part, has an environment not paralleled in any part of Europe. The aim of such a society would be to collect and disseminate by discussions, lectures and publications, all geographical data concerning Australasia and cognate regions. In effect, *the study of the Australasian Environment and its relation to Man* might well be adopted as the motto or slogan of the proposed society.

Following the issue of this notice, a meeting was held in the Lecture Hall of the Royal Colonial Institute on May 20, when it was determined to form a society; questions of constitution, subscription, etc., being discussed in some detail. It was also agreed that a Journal should be issued as an important part of the work of the organisation. At this meeting a Provisional Executive was elected, with Sir Owen Cox as President. Sir Owen accepted this only on the understanding that the Executive was a purely provisional one, pending the calling of a truly representative meeting. A meeting of this Executive was held on June 14, when further matters of importance were dealt with and straightened out in preparation for a general public meeting.

On August 10, the first General Meeting was held in the Lecture Hall of the Royal Colonial Institute. A regular council was elected, rules were passed, and a general scheme of work was propounded and entered upon. Professor Griffith Taylor was unanimously elected as the society's President in view of his great work toward the advancement of the study of Man and his environment, and of general geographical research in Australia. The personnel of the General Council elected at this meeting is furnished on page 2

of this Journal—the General Council elected at the Annual Meeting on July 10, 1928, being also given. The rules also have been published in this part, for the guidance of members of the society and the information of intending members. It may be mentioned, however, as being of public interest, that it was determined to hold monthly meetings for lectures and discussions on all matters pertaining to the wide objects of the society, that a Journal should be issued as soon as practicable, and that—with a view to attracting the largest possible membership from all sections of the public—the subscription should be fixed at ten shillings per annum. The rate for student members was fixed at only half that amount, so as to assist them in their work as far as possible. The very satisfactory roll of membership of the society may be taken, we think, as evidence of the public need that the organisation is filling; and it may be safely prophesied that a very successful future awaits our labours.

With the present issue of *The Australian Geographer*, the Geographical Society of New South Wales initiates what, it is hoped, will be a regular series of parts of their official journal. Though this is the first part to be published within the year, it is confidently expected that the support given the society will be great enough to enable the regular publication of, say, quarterly parts later on. In the meantime, our publications will issue as funds permit. The present part includes papers and notes on lectures, which the Editors think are of importance, and certainly of great interest, to the community; and they feel a certain meed of satisfaction in being able to present such a variety of Geographical "good things" in this first number. It is hoped that the publication of the Journal will, while adding greatly to the society's usefulness, be a ready means of recruiting members to the ranks of the society.

We cannot close this preliminary note without referring to the highly constructive work performed by the original committee of the society in its initial stages. Special reference should be made to the work of Captain Pearse and Sir Owen Cox, and to the aid in financial matters given by Mr. M. Frank Albert, our Honorary Treasurer.

Our Crest-Map

The Crest-Map which has been adopted by the Geographical Society of New South Wales, and which figures on the title-page and wrapper of this journal, is worthy of some little notice. A glance at it will indicate at once the all-embracing character of our studies, and the wide scope that there is for our future activities.

The interlaced circles are adapted from the design of Von Engeln in "Inheriting the Earth." This adaptation, with the addition of the Sylvanus Projection of the World and the central title, is the work of our President, Professor Griffith Taylor. Miss Ruth Godden made the drawing from which the block was made.

This Crest-Map may be regarded as the official badge of the Geographical Society of New South Wales, but there is no objection to its reproduction elsewhere—or of any of the matter contained in our official Journal—provided that full acknowledgment is made.

D.R.T.
D.G.S.

The Status of the Australian States

A Study of Fundamental Geographical Controls[1]

By GRIFFITH TAYLOR, D.Sc., B.E., B.A.
(Professor of Geography, University of Sydney).

CONTENTS

Part I.—The Controls.

One of the most interesting aspects of Australian Geography lies on the borderland between economic and political geography. It concerns the relative endowment of the several States of the Commonwealth. For the purposes of this study, I propose to consider the seven main political divisions of Australia as my units. These, arranged in order of their foundation, are New South Wales, Tasmania, Western Australia, South Australia, Victoria, Queensland and Northern Territory. The latter, truly, has recently been again subdivided along latitude 20°S. into two nearly equal parts—Northern Australia and Central Australia. I shall have something to say about this subdivision later, but for the present we can consider the seven original divisions only.

We may consider very briefly the main changes in the boundaries of these seven divisions. Our own State of New South Wales has been sadly diminished by the whittling away of younger States. In 1788 it included almost the whole of Australia, except that part which afterwards became

[1] Presidential Address given before Society at Annual Meeting, July 10, 1928.

Western Australia. This area amounted to 1,454,312 square miles on the mainland (*i.e.*, all east of 135°E. longitude) together with 26,215 square miles in Tasmania. In 1825 the latter colony was separated; but the western boundary of New South Wales was extended to 129°E. (the present boundary of W.A.). This was its greatest extent, and the colony then included 1,552,586 square miles. This state of affairs continued to 1836, when South Australia was separated with 309,850 square miles. It was enclosed on east, north and west by New South Wales; for a forlorn fragment, sometimes known as No Man's Land (N.M.L. on map), still belonged to the Mother Colony until 1861. This fragment had been isolated from New South Wales by the creation of Queensland in 1850, while Victoria had separated in 1851. Thus in 1857 New South Wales still owned 1,020,412 square miles, including Northern Territory and No Man's Land. Another strip was taken from our State when the Queensland boundary in the north-west was moved to its present position in 1862, so as to include Gregory's "Plains of Promise" and much of the Barkly Tableland. Later modifications are due to the expansion and contraction of South Australia.

FIG. 1.—The evolution of the chief political divisions of Australia. (*Partly after Cramp.*)

As the result of Stuart's explorations, South Australia was permitted to annex the region to the north. This state of affairs continued until 1911, when the Northern Territory (with nearly 3½ millions sterling of debt) was transferred to the Commonwealth.

It is quite natural that these States and Territories should have been demarcated without reference to the natural resources of the areas concerned. Very little attention is paid to environment even to-day, area apparently counting for more in the eyes of many Australians. If, however, we cannot blame British and Colonial administrations in the past when the geographical controls were quite unknown, we must blame ourselves to-day if, as a society, we do not do our best to make every Australian citizen understand what is, perhaps, the chief factor which is moulding the present and future prosperity of the Commonwealth.

As the States are now arranged, it might at first glance appear that their final importance would depend to a great extent on their relative areas. These are given in the following table, and this Address is largely an attempt to show that their order of importance is that given in the final column, and has little to do with mere area.

AREA AND IMPORTANCE OF STATES

State, etc.	Square Miles.	Order.	Real Importance.
Western Australia	975,920	1	3
Queensland	670,500	2	1
Northern Territory	523,620	3	7
South Australia	380,070	4	5
New South Wales	310,372	5	2
Victoria	87,884	6	4
Tasmania	26,215	7	6

Upon what is the importance of Australian lands based? No doubt there are many factors involved, but essentially Agriculture, Pasture, Mining and Manufactures are the controlling factors. These, in turn, can be expressed in simpler units. Thus, agriculture is a function of temperature, rainfall and soil. Pasture is a function primarily of rainfall, though soil is also of importance. Mining is almost entirely controlled by geological conditions, though the necessary presence of water and fuel brings in the other controls to some extent. Manufactures are largely a function of coal or hydro-electric power. The latter, in turn, depends essentially on rainfall, and, to a less degree, on topography.

The investigator, therefore, must first study the geological conditions with a view to ascertaining where coal and metals are likely to occur. He must study topography in connection with hydro-electric power, and soil in connection with agriculture. Above all, he must know the varying conditions of temperature and rainfall. This brief consideration should indicate clearly that if the mantle of the prophet has fallen on anyone, it is on the shoulders of the geographer, though usually the politician has claimed it as his own!

Let us consider the most difficult problem first. Where are valuable ore deposits likely to occur in Australia?

The series of small block diagrams in Figure 2 has been drafted from various papers, but chiefly from those of Dr. Bryan, Dr. Walkom, and Mr. Whitehouse. They show the main features in the past geography of Australia as well as we can reconstruct it. For the approximate length of years, I have adopted the figures I used in 1919 in my studies of Climatic Cycles, which agree fairly well with later determinations. Such dates are naturally speculative, being based on the radio-active decay of minerals in the rocks of the period concerned.

In the small diagrams the oldest (Fig. 2a) represents the main features of Australia in Cambrian Times. We notice three large gulfs around Darwin, Adelaide and Melbourne. In these fairly shallow seas, sands and shales and limestone reefs were built up which contained relics of the Cambrian life now represented by their fossils. It is not always understood by students that the fossils usually show where the *seas* were, not where the land was in the epoch under consideration. In the west was that solid, resistant block which has practically always been a continental area since the dawn of geological history. It is known as the West Australian Shield. Eastern Australia has proved relatively mobile in the ensuing 450 million years. Our maps show that right up to Triassic times (*i.e.*, for 350 million

years) the main feature in the building of the continent was that the coastlands east of the Shield gradually expanded from Cambrian times until the seas were pushed to the present east coast, and indeed, in Triassic times, became an enclosed brackish lake. As a result of this slow movement of the seas to the east, we find a regular sequence of sediments laid down (between the Shield and Brisbane) in the normal order from Cambrian through Ordovician, Silurian, Devonian, Carboniferous, Permian and Tri-

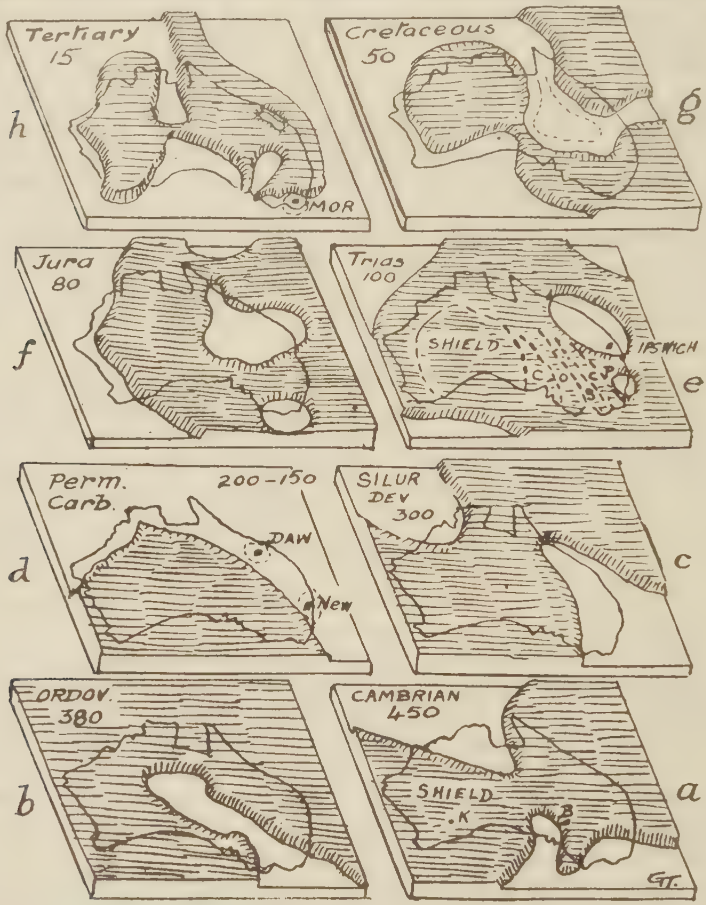


FIG 2.—Tentative reconstructions of Australia in past times, at periods indicated in millions of years. The towns shown are noted mines. In the Triassic map (2e) the successive sediments deposited to the east of the shield are indicated by initials. (Coal in lakes.)

assic. This is indicated in a *generalised* fashion by the initial letters in Figure 2e. We must picture these as a series of beds all dipping to the east, with the eastern later deposits of course overlying the western older deposits. (A Permian "coal lake" in Tasmania has been omitted.)

After Triassic times a broadening of the Triassic lake occurred, so that most of Queensland was under water. Later a new encroachment

of the sea occurred in Cretaceous times, which caused more of Queensland and much of South Australia to be submerged. From field-work near Tarcoola, the writer is satisfied that a belt of granite forms a wall between the Queensland Artesian Basin and the Eucla Artesian Basin (which are both Cretaceous in part). It may not, of course, have been so prominent in the past. (See Fig. 2g.) In Tertiary times Australia probably for the first time had a shape somewhat like its present form. But deep gulfs have marked its outline in late Tertiary times, though it seems unlikely that Australia was joined to Asia or New Zealand in any part of this period. (Fig. 2h.)

The economical results of this varied history are important in three major respects. These concern metals, coal and artesian water. Speaking generally, metals occur most frequently in ancient faulted and folded rocks. These have usually been exposed at the surface by uplift and subsequent erosion of the upper portions of the crust. The ores of gold, copper, etc., are often deposited from heated solutions, which need cracks or channels for their transport. They apparently come primarily from deeper portions of the crust, and need long periods for notable supplies to be deposited. Under such circumstances we find that nearly all our chief mines, such as Kalgoorlie, Wallaroo, Broken Hill, Cobar, Mt. Lyell, Mt. Isa and Mt. Morgan occur where ancient folded and faulted rocks have been exposed to the surface by uplift (often of late date). I have indicated these places on the diagrams by their initials. (See Figs. 2 and 3.)

There is little use in prospecting for metals in the deposits laid down in Permian or later times, so that central Queensland and northern New South Wales, the lower Murray region and the Nullabor Plains are of little use to their respective States as far as valuable minerals are concerned. It seems likely also that large areas of relatively *undisturbed* rocks (even though they are very old) are not hopeful for minerals. There is a marked change in the northern half of the great Shield, which makes the more or less level-bedded rocks of the desert region of Western Australia less likely than the crumpled rocks of the Kalgoorlie region to contain auriferous deposits.

As regards artesian water, the beds must be nearly level or only slightly folded. A region which has been subsiding slowly for long periods is also favourable. These conditions are met with in the Cretaceous deposits of Queensland, and also in the Tertiary beds of Eucla and the Lower Murray. It would be foolish to expect an Artesian Basin in the centre of Australia, where ancient impermeable beds form the actual surface. There is, however, a region behind Broome, though no one knows its western edge, which may contain artesian water. (There is, of course, shallow ground-water throughout Australia.)

Finally, coal in Australia is all Permian or later in age. Here again conditions involving the slow subsidence of huge freshwater lakes are practically essential. Thus, we are not likely to find any notable coal in older deposits than the Permian; so we see that coal and metals are complementary to each other in the geological record. Luckily each of the later epochs has furnished valuable coal, but all notable deposits are found in the mobile eastern portion of the continent. Newcastle coal (eleventh

in the world's resources) and Dawson River (Baralaba) coal are Permian, and were laid down in lakes on the borders of the Permian Sea. (See Fig. 3.) Ipswich coal was deposited in the Triassic Lake and Wonthaggi coal in the temporary Jurassic Lake of Victoria. The valuable Morwell coal (the nineteenth deposit in order of magnitude in the world) was formed in a slowly subsiding lake-floor in Miocene times, and is of the remarkable thickness of 700 feet. It is difficult to estimate the total amount of coal, but the following table is based on "Power Resources" and the Commonwealth Year Book:—

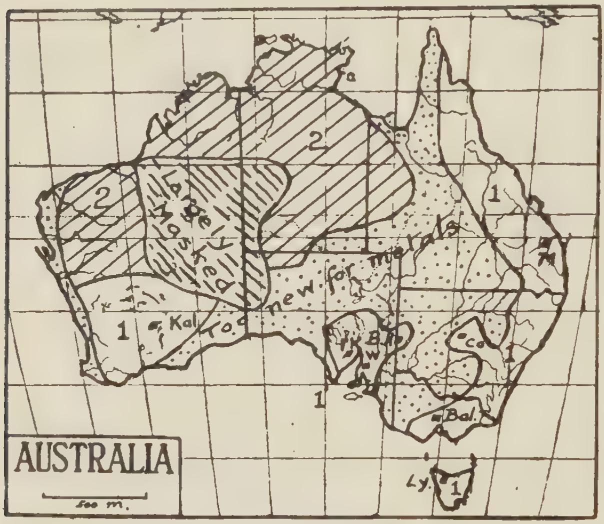


FIG. 3.—A much-generalised map showing where valuable metals are likely to be found. 1 is best, 2 is next. There is little likelihood of finding them in the other regions.

CHIEF COAL RESERVES OF AUSTRALIA

	Accessible Reserves. Million Tons.	Probable Total. Million Tons.
New South Wales—		
Total	20,000	120,000
Victoria—		
Morwell	11,000	—
Wonthaggi	25	—
Total	—	12,000
Queensland—		
Callide	100	—
Clermont	300	—
Dawson	70	—
Ipswich	243	—
Mackenzie	530	—
Total (with the rest)	—	2,000
Western Australia	—	3,500
South Australia	—	50
Tasmania	125	250

In this table the last column is somewhat speculative.

The world's total coal resources are said to be 7,937 thousand million tons. The chief supplies are: U.S.A., 3,838; Canada, 1,234; China, 995; Germany, 400; Britain, 189; Siberia, 175; and Australia, 139 thousand million tons.

The next table shows the production of the chief minerals in the States. The past production (as Keith Ward points out) is no clue to future mineral prosperity. Hence the second table, with the production of the last few years, is a better guide to the mineral assets of the States.

MINERAL PRODUCTION TO END OF 1925 (Millions Sterling)

	N.S.W.	Vic.	Q.	S.A.	W.A.	Tas.	N.T.	Australia.
Gold	64	303	86	1.6	157	9	2	622
Silver Lead ...	105	—	4	—	2	8	—	119
Copper	16	—	26	33	2	18	—	94
Iron	6	—	—	5	—	—	—	11
Tin	13	1	10	—	1.5	16	.6	43
Zinc	19	—	—	—	—	—	—	19
Coal	151	.8	14	—	4.5	1.3	—	179
Grand Totals	380	314	144	43	167	54	3	1104

MINERAL PRODUCTION (Average Last 3 Years)

	N.S.W.	Vic.	Q.	S.A.	W.A.	Tas.	N.T.	Australia.
Coal	9.0	.6	1.0	—	.4	—	—	11.1
Silver Lead	4.2	—	—	—	—	—	—	4.2
Gold	—	.3	.4	—	2.1	—	—	2.8
Zinc	1.3	—	—	—	—	—	—	1.3
Copper	—	—	.3	—	—	.4	—	.9
Tin	.2	—	—	—	—	.2	—	.9
Iron	.6	—	—	.6	—	—	—	1.2
Grand Totals	15.0	1.0	2.2	1.0	2.6	1.3	—	24.0

In the above table the grand totals include other minerals besides those listed. It will be noticed that the high total production of Victoria is based on the early gold yields. Broken Hill and the Greta Coalfield (near Newcastle), both in New South Wales, are the great mineral assets of Australia to-day.

Soil and Topography.—These may be considered together for reasons which will probably be new to many readers. Speaking broadly, good soils are often of three main classes. Great areas of *river alluvium* are practically inexhaustible. They occur primarily in inland areas of recent subsidence, such as the Hungarian Plain (with its wheatfields) or the Lombard Plain. Other great areas of such *alluvium* are found at the mouths of huge rivers like the Mississippi, where the crust has been subsiding or nearly stationary. In Australia most of the continent has been elevated in the *last* phase of its history; this period has been named the Kosciusko epoch, for the reason that the crustal block forming our highest mountain was then elevated. All round our coasts is the evidence of this elevation in the juvenile gorges of almost all the rivers, or in the great cliffs of the Bight, etc. In

Northern Territory this late elevation largely accounts for the absence of deep soils in most of the region. On the other hand, the Darling Basin contains large areas of fairly deep soils, but, unfortunately, this and allied regions are largely semi-arid. So also the plains of south-western Queensland and near Lake Eyre probably consist in part of deep loam, but here again Nature has arranged things very badly, giving us good soil and poor rains, or good rains and a rugged (recently uplifted) topography.

The weathering of soft Tertiary rocks gives rise to good soils in many countries. As reference to Fig. 2h shows, only near the Lower Murray and on the Victorian Coast are there small moderately well-watered regions of this type. Our continent has been remarkably stable during the troubled times of the later Tertiary period; while the Himalayas and Andes were rising from sea-level. But if we are free from the earthquakes and volcanoes which inevitably accompany the stresses of mountain-building, we have, *per contra,* practically no grand scenery and only small areas of rich volcanic soil among our three million square miles of territory. These sparse basaltic regions are naturally associated chiefly with the *margins* of the continent, which have been mostly affected by the Kosciusko Uplift in late years, or by the faulting and folding of earlier Tertiary times. A series of basalts extends from the Atherton Plateau in Queensland, through the Mount Sturgeon and Buckland Tablelands, by way of the Darling Downs and Lismore-Dorrigo Basalts to the Liverpool Range and other lavas in New South Wales. Perhaps the largest flow of all covered the western valley of Victoria in late Tertiary times. Too little is known of the distribution of soils in Australia, or of the best indicator of soil-values, the natural vegetation. No time should be lost, as the writer has pointed out for years, in carrying out a reconnaissance survey of these two "indicators" of the resources of Australia. There is here a most valuable field (for young geographers with adequate geological or botanical knowledge) which will furnish research for the next half century.

As regards topography, it is customary to blame late topographic changes for much of our inland arid environment. It is true that the whole Shield has probably been elevated several hundred feet in Pleistocene times, while the eastern highlands have been raised by simple folds or as crustal blocks several thousand feet. The Flinders Range also forms a meridional ripple in the crust connected like the Eastern Highlands with crustal collapse in the Pacific along the Tonga-Kermadec Abyss. But as we learn more of Paleo-Climatology we find that more potent factors than topographic change have been affecting our climate. It seems likely that the fluctuations in Solar activity (described briefly by the writer in 1923, and much more completely by Kidson and Quayle in 1925) are competent to produce remarkable changes in rainfall without any change in the topography. Our arid central regions would not probably be greatly benefited by the removal of the highlands from the east coast to the interior. The Chilian Andes are over 15,000 feet high, yet both flanks are arid near the Tropic of Capricorn, just in the same latitudes as our desert. In other words, it is the presence of the belt of High Pressure with the associated drying winds which determines both arid belts. Probably the position of the high pressure belt

depends directly on the variations in solar energy, but this is a very vexed question and cannot be dwelt upon here.

As regards disabilities due directly to elevation, we see them most markedly in Western Tasmania, and in the hinterland from Canberra to Melbourne. Here the temperature is lowered from 8 to 18 degrees Fahrenheit, and as the rainfall is heavy, there results an environment characterised by a sub-Alpine Vegetation. It is no more attractive or useful than the somewhat similar environment in the Welsh or Scotch Highlands, which are largely given over to cattle and tourists.

It is otherwise with the highlands comprising the Blue Plateau, New England and the Atherton Plateau (the sole notable elevation in tropical Australia). Here the cooling of 3°F. for each 1,000 feet of elevation is a distinct advantage. In the Blue Plateau the elevation of 3,000 feet has led to the tourist towns of Katoomba and Lawson, etc. But the extreme erosion by the coastal rivers has produced a rugged topography which is a great handicap to settlement. Probably of no other city of one million inhabitants could it be said that it is so shut in by a barren hinterland at a radius of 50 miles that this margin is almost as empty of settlers as in the time of Captain Cook. Somewhat the same conditions obtain throughout the highlands in the east of New South Wales. I have made an estimate, based on the distance apart of the local post offices, of the extremely sparsely populated portion of eastern New South Wales. It has an ideal climate with a rainfall over 25 inches. But about 23,000 square miles (or 30 per cent. of this best-watered strip) is almost devoid of settlers, chiefly because of the rugged topography.

As a whole, our continent is low. In the west much is about 1,200 feet, but very little is above 3,000 feet. In the east are great areas of lowland. The comparatively cool nights of inland areas are often mistakenly explained in terms of the elevation. The chief factor prabably is the aridity. This implies an absence of cloud, and, in consequence, the ground heated in the day radiates its heat very quickly after sunset, giving relatively cool nights. This is an advantage, but the nights would probably be little warmer if the centre were even lower than it is. There are considerable areas higher than 2,000 feet around Alice Springs (about 40,000 square miles) and near the head of the Fortescue River (30,000) and near Wiluna (12,000). But in all of these the rainfall is so low, ten inches or less, and the evaporation so high that such plateaux are of use only for sparse pastoral holdings.

The temperature control is, of course, of great importance, though indirectly, in general. Of the three million square miles in Australia, just over one million is situated north of the Tropic of Capricorn. I do not propose to consider Tropical Settlement in any detail in this address, but I have drawn a map (Fig. 4) which must convey to every one the fact that very little of our Commonwealth has an environment such as our British forefathers were accustomed to. This map is based on a detailed study of "homoclimes" (*i.e.*, regions of similar climate) which I made in 1916. We should all consider that most of India has a climate not very suitable for close white settlement. Yet a reference to the map in

Fig. 4 shows that our northern coastlands have practically the same climate as that found in India from Calcutta down to Ceylon. So also Broome is like the mouth of the Congo. Alice Springs recalls the northern edge of the Sahara. On the mainland, our coolest large town (Melbourne) is very like Oporto on the coast of Portugal, and only in Tasmania do we find a region something like that unusually warm portion of Britain around Falmouth. However, it is only in such places as Marble Bar (W.A.) (M. in Fig. 4) that extremely high temperatures are met with. Here during the summer of 1921-22, the thermometer rose on an average to 110° for a period of 3½ months. So also Wyndham (W. in Fig. 4) in the extreme north of Western Australia seems to have a hotter climate (84.5°F.) than any other place in the world with a reasonable rainfall.

The Rainfall is, of course, the key to Australia's prosperity. There are foolish folk who stoutly deny that Australia is an arid continent. This is because they know nothing of other lands and very little of their own.

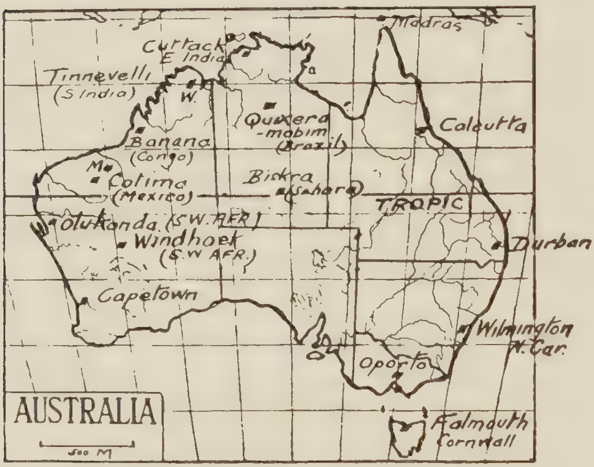


FIG. 4.—Places with the same climate as Australian localities. M = Marble Bar, W = Wyndham.

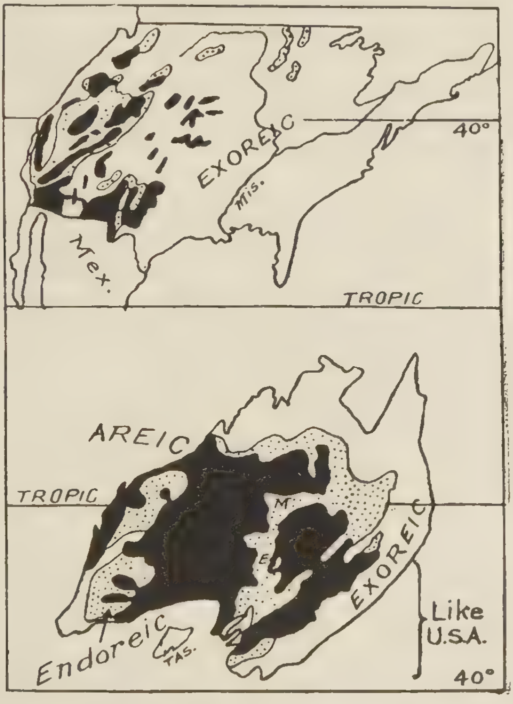
I have made an estimate of the percentages of the well-watered and of the arid country in the six large inhabited areas. It explains our small population, and is the best guide to our future status.

APPROXIMATE RAINFALL AREAS (Percentages)

	Size.	Average Temp.	More or Less HUMID. Over 40in.	40in.-20in.	DRY. 20in.-10in.	Under 10in.
Australia	1	70°	11	22	30	36
Europe	1.3	45°	0	52	42	5
Asia	5.3	40°	15	18	32	35
Africa	4.2	75°	28	18	17	37
North America	3	45°	18	30	37	15
South America	2.4	75°	76	8	5	11

Of the three hot continents, Australia has 66 per cent. dry and 33 per cent. more or less humid. Africa has 54 per cent. dry, and South America has only 16. The other continents are so cool that they are not comparable, for the 66 per cent. of dry land in Asia has a low evaporation.

A noteworthy study of the world, as a whole, has recently been made by the eminent French geographer, Professor De Martonne. He is primarily concerned with the drainage of the various lands of the world. In Figures 5 and 6 I have traced his maps for U.S.A. and for Australia. He classifies the lands according as they possess "through drainage" to the ocean (which he calls "Exoreic"), or whether they belong to basins of interior drainage ("endoreic"). To quote his words, "The deserts are *par excellence* the domain of interior-basin drainage; but they present a particular case where run-off is nil. For this the term '*areic*' is proposed." He adds to areic regions some areas which do not originate rivers that reach the sea. "A river crossing the region without rising therein does not change the areic character." Hence the lower Nile and lower Murray flow through areic regions, where, indeed, they actually lose volume.



FIGS. 5 and 6.—Maps traced from De Martonne and showing (in black) relative portions of Areic land (i.e., with no run-off) in U.S.A. and Australia. E = Lake Eyre and M = Macdonnell Range. Endoreic = Internal drainage; Exoreic = Ocean drainage.

Some critics complain that the word "desert" to the layman means something very different from what the geographer means by it. This may be true, but one can only retort that there are a dozen sorts of country called "desert" by the layman (such as the sandy areas in central Queensland), some of which no geographer would term a desert at all. However, let us consider the relative areic areas in U.S.A. and in Australia as charted in the large world-map by De Martonne. It should be obvious to anyone that the riverless areas in the two countries, which are the same size, are hardly comparable. Nor, unfortunately, are the areas with adequate rivers. To quote the French authority, "Australia has the record for *endoreism*,

64 per cent.; and for *areism*, 43 per cent. It is the only continent traversed centrally by the tropic. Its relief is nowhere sufficiently important to favour precipitation save on the eastern coast." In the face of this, is it not stupid of certain ignorant Australians to complain that the geographer dwells too much on the arid regions of Australia? It is to be noted that while all deserts are areic, there are certain areic regions which are not desert, though they are almost always dry. (Certain limestone or "Karst" regions furnish obvious examples.) Of the rest of the world, the Sahara has four times as much areic country as Australia. Arabia, Russian Turkestan and Chinese Turkestan have each about the same area of areic land as Australia.

Part II.—The Industries.

We may now turn from fundamental controls to resulting industries. Of these, agriculture is the first to be considered. While our total of tilled land is very small (about 17 million acres), yet it is capable of tremendous increase. This, however, is not going to take place primarily in new regions, but by intensive culture of areas already in part occupied by the farmer.

As regards agriculture, about 70 per cent. consists of wheat or wheaten hay, while 84 per cent. is made up of various forms of wheat and oats. We may, therefore, devote special consideration to wheat. The general distribution is shown by the closely ruled areas in Fig. 7. If we try to find the natural control bounding the wheat on the dry side in New South Wales, it is clearly not the annual isohyet for 10 inches. But if we plot the rain-line which shows the areas which receive 10 inches in the growing period (which in Australia is the winter from April 1 to October 31), then we obtain an isopleth which is very close to the arid limit of wheat culture. It is plotted as the "10-inch winter" line (or isopleth).

In 1915 the writer published the first detailed economic atlas for Australian wheat, cattle and sheep. In this memoir he showed that wheat would certainly spread into the Esperance region in Western Australia. (See Wh. in Fig. 7.) In Eyre's Peninsula it must largely expand. So also the Pinnaroo region and the Mallee nearby in Victoria, were obvious wheat fields of the future. Most of these areas have been exploited in the last dozen years. Later maps have been produced by Mr. Thomas for 1918, and by the writer for 1923, and recently in the Commonwealth Yearbook for 1924. They all, of course, show very little variation in the position of the wheat belt as regards Australia as a whole. This is the very point where the geographer and the agriculturalist have different aims. The latter is interested in extending the wheat belt by a dozen miles or more into the arid west. The former is more concerned to enlighten the public as to the environment in the enormous empty regions of our Commonwealth. Quite recently a Commonwealth Senator asked the writer if he did not think that such experiments as Farrer's on wheat-breeding would result in important wheat crops in the heart of arid Australia. It is perhaps unnecessary to say that I know of nothing which justifies such unwarranted optimism.

In the years from 1904 to 1922, the wheat belt has spread from Forbes to Hillston in central New South Wales. This is a distance of 160 miles. In the north of the State, the wheat line has been extended about 30 miles to the west in the same time. This is notable movement, but it is not likely to continue at anything like the same rate. Nor does it affect the Australian areas much as a whole, since the arid (non-agricultural) belt extends some 2,000 miles to the west of these places.

There is, however, one other region where wheat will be grown, which appears to have been ignored up to date. This is in the east-central portion of Queensland. As the writer pointed out in 1915 (in his atlas memoir "Climatic Control of Production"), the wheat of the Jabalpur region in India is grown right on the tropic with a temperature varying from 64° to 71° in the growing season. The region in Queensland around Emerald (See Wh. in Figure 7.) has much the same conditions as part of the Indian

Fig. 7.—Salient features of Australian Agriculture (black circles from "Inlander" show actual acreage tilled). Present wheat lands are ruled.

wheat region, *i.e.*, a dry winter and spring, with only 5 to 10 inches of rain. Wheat here would be planted in March at the end of the summer rains (14 inches). It would ripen in three or four months, receiving another 5 inches during its growth. This, in the writer's opinion, is likely to be an important extension of the wheat area if suitable breeds of Indian wheat are introduced.

Finally, the Texan wheat-climate is not unlike that between Emerald and the Darling Downs, so that Queensland is likely to make large strides in her future wheat production.

There would appear to be no great difficulty except shortage of labour in growing large crops of various millets, etc., in the centre of Queensland, where there is a summer rainfall of about 20 inches, and a

range of temperature from 80° in January to 64° in July. Similar climatic conditions are common in much of Rhodesia where Kaffir corn and maize are largely grown.

As we move to the west, however, the rainfall becomes more and more seasonal. The writer sees no hope of important agriculture in the Northern Territory or in Kimberley. The soils are, on the whole, poor, but crops of cotton are grown in the rich soils of the Deccan (India), where the climate is somewhat like that of the Victoria Basin in the west of the Territory. Summing up the whole question of tropical agriculture, it seems certain that until the sugar coastlands of Queensland and the adjacent hinterland are fairly fully occupied, there is no probability of notable agriculture in the greatly inferior lands of the north and north-west. I have shown on the map (Fig. 7) the most likely extensions of wheat (Wh.), millets and cotton in the new lands of the north-west and north.

The actual acreage in wheat has fluctuated a good deal, according to the world demand, and to the shortage of labour. But considering the last ten years there has been most advance in Western Australia, while Tasmania is negligible. The four States of New South Wales, Victoria, South Australia and Western Australia are of approximately equal importance.

AREAS UNDER WHEAT (The figures are millions of acres)

	N.S.W.	Vic.	Q.	S.A.	W.A.	Total.
1916-17	3.8	3.1	.2	2.8	1.6	11.5
1926-27	3.3	2.9	.1	2.7	2.6	11.7

There appear to be about 400,000 square miles of land which, as far as climate is concerned, are favourable for wheat. They are arranged somewhat as follows:

N.S.W.	100,000	square miles
Queensland	100,000	,, ,,
Victoria	70,000	,, ,,
Western Australia	60,000	,, ,,
South Australia	40,000	,, ,,
Tasmania	20,000	,, ,,

From these we must subtract a great deal as the result of rugged topography and unsuitable soils. An estimate of the area in the United States climatically suitable for agriculture is about two million square miles. Only about half a million square miles are actually utilised, in spite of a strong demand for farm lands; using the same proportion, we may consider that 100,000 square miles are available in Australia.

Since only 16,000 square miles (10 million acres) are at present cultivated, there is obviously room for a tremendous increase of population living on the wheat belt. Furthermore, if we accept 2.5 acres as necessary to support one person (as East estimates), this future wheat area will maintain 25 million people.

The pastoral industries may now be briefly considered. Here again the geographer and the layman may appear to be at variance, unless a fundamental principle is made clear. For instance, the layman calls the region of the Macdonnells in central Australia "wonderful cattle country." The geographer calls it "poor, or sparse, cattle country." The same is

true of most of arid west Australia, say in the Murchison or Laverton districts. The reason lies in a consideration of the "density" ~~of~~ the stock. No one knows better than the geographer that semi-desert country will produce a few satisfactory cattle. Why should it not? Such an environment is the natural habitat of both cattle and sheep. But he does not consider that one head of cattle to the square mile (as in the *settled* portion of the Macdonnells) is the mark of "Good" pastoral lands. From 10 to 40 head (or thereabouts) to the square mile is the density throughout all the wetter lands of Eastern Australia. This is "good country for cattle" in the

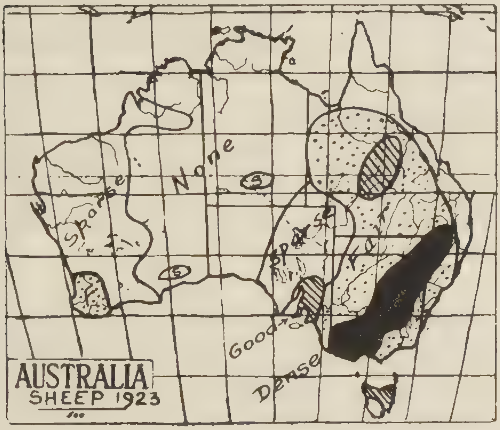


Fig. 8.—Density of Sheep in 1923. Sparse regions (and other blank regions) are negligible for sheep.

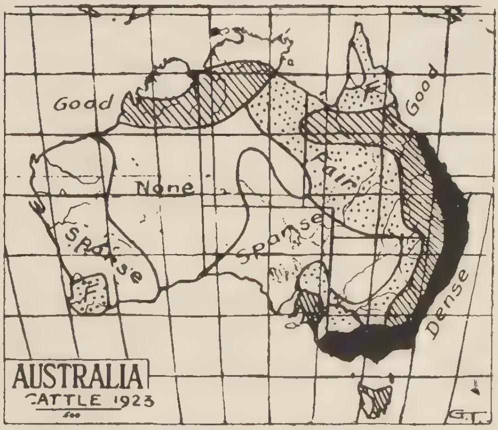


Fig. 9.—Density of Cattle in 1923. Sparse regions (and other blank regions) are negligible for cattle.

geographic sense. From 10 to about 2 he calls "fair," and below a density of 2 per square mile it is "poor," or "sparse." (In Figs. 8 and 9 the classes are somewhat generalised; the writer is publishing more detailed maps elsewhere.)

From this point of view, Queensland, New South Wales and Victoria are the only important cattle States. In 1924 they contained 82 per cent. of all the cattle. The significant point to notice is that no part of the other States (although they contain 62 per cent. of the area of Australia)

can become as important as the present-day cattle-lands of the east, owing to their climatic disabilities. The northern cattle belt from Kimberley through the Victoria Basin to Barkly Tableland is only of the second rank.

In the map I show the distribution of cattle in 1923. I have given arbitrary names to the grades, but their relative values are likely to hold good for many decades. Indeed, our pastoral lands are now fairly well "saturated" in that there are no entirely new areas available. The future increases will almost wholly be due to more intensive methods of utilising the lands already leased.

In the following table I show the variation in the cattle in the several States during the last fourteen years. Only in Queensland and Northern Territory has there been any notable change:

CATTLE (In millions)

	N.S.W.	Vic.	Q.	S.A.	W.A.	Tas.	N.T.	Total.
1910—Cattle ...	3.1	1.5	5.1	.4	.8	.2	.5	11.7
1925—Cattle ...	2.9	1.5	6.4	.4	.8	.2	1.0	13.2
1925—Density ..	9	17	9	1	1	7	2	4

As regards sheep, somewhat similar conditions are indicated in Fig. 8. Here again the east is the great sheep country. It is most important to realise that the more arid half of Australia is negligible as a sheep producer. The densest belt of sheep lies in wetter country than the densest belt of wheat. In other words, it is probably the man who carries out "mixed farming" and not the owner of the outback sheep-station who is contributing most to the wool wealth of Australia. Here again the three States of New South Wales, Queensland and Victoria contribute 84 per cent. of the sheep of the Commonwealth. As we shall see in a later paragraph, the pastoral resources of Western Australia, South Australia and Northern Territory are poor, and relatively will remain so. This statement will, as usual, be hotly denied by many "boosters" in the large States concerned. I will ask them, however, to try and realise what De Martonne's map in Figure 6 implies as to the relative merits of the Eastern third and Western two-thirds of Australia.

The following Table shows that the sheep industry is fairly stable. In 1908 there were 87 millions, and in 1924 there were 93 millions. Very little alteration in the proportions has occurred in the last 16 years. The densities per square mile also indicate the chief "sheep States":

MILLIONS OF SHEEP

	N.S.W.	Q.	Vic.	S.A.	W.A.	Tas.	Total.
1908	43.3	18.3	12.6	7.0	4.1	1.7	87
1924	47.0	19.0	12.6	6.3	6.4	1.6	93
Density, 1924 ...	151	29	142	17	6	61	31

The small importance of Western Australia as a sheep country is clearly shown in this table. In all the Northern Territory there are only a few thousand sheep in the extreme south. A valuable paper by Wynne

Williams in the *Geographical Journal* (January, 1928) shows that much of the Barkly Tableland, in the north-west of the Territory, is suited to sheep. This paper, with its clear maps, is of a type which should be copied for every pastoral region in Australia, and the present writer is glad to think that he was instrumental in getting it published.

It is advisable, perhaps, to dwell on one or two other aspects of the pastoral industry which are often misunderstood. The present pastoral lands were all more or less known in 1862. Very little of Australia, except those regions which have resisted any pastoral occupation (*i.e.*, the deserts) remained to be explored after that date. Of course, the explorers were almost always keenly interested in good pastoral lands, and any they discovered were soon taken up. Hence the lands still totally unoccupied are in this state because they are most unattractive, not because they are unknown. The second point also concerns these uninhabited regions. If they have no settlers and no rain gauges or thermometers, how can the scientist tell what the environment is like? He uses the *isopleth* method. He knows that the great uninhabited area is relatively level and about 1,200

Fig. 10.—Variation in population density from 1901 to 1921. Black unchanged. Ruled areas are where population has spread. Dotted areas where density diminished.

feet above the sea. He draws the isohyets (rain lines) for the margins of this desert, and it is clear that all these lines are roughly oval and surround still drier regions in the uninhabited area. He draws lines of rainfall-variability, and so can deduce that the unoccupied territory is worse in this respect. He does the same for temperature, for heat-spells, and for evaporation. All show that the controls in all probability are less favourable in the uninhabited region. In fact, the region is unoccupied just for that very reason.

Part III.—The Relative Values of the States.

There is one fairly conclusive test as to whether the geographer or the booster is correct as to the factors determining population, and that is to appeal to the density of the population itself. If inland Australia is a region of vast economic possibilities, one would expect some sign of it in the spread of population during the last twenty years. If the possibilities of close settlement are confined to the well-watered east and south-west, then no notable change should be indicated in the population

map in regard to these inland areas. Reference to Figure 10 will show that there has been no noteworthy change in population in any part of inland Australia (except perhaps around the West Australian mines) from 1901 to 1921. The map shows the isopleth of *one person to four square miles.* The black areas had greater density than this in 1901, and still have over one person to four square miles. The ruled areas are where population has spread in the twenty years. The chief regions are near Barcaldine in south central Queensland, in the Pinnaroo region (S.A.), and in the wheat lands of Western Australia. On the other hand, the dotted region just to the north-east of Barcaldine seems to have lost population, as does some of central New South Wales. (Possibly in these latter cases the use of differing census districts may explain the apparent losses.) At any rate, speaking generally, the uninhabited lands have remained without a settler, and the lands of extremely sparse settlement are still of negligible value compared with those somewhat limited regions where the geographer believes that the future millions of Australians will settle.

It has seemed an interesting problem to see how one could divide Australia into six States, each of which would be more or less equally endowed by Nature. In this problem one may assume that the presence of very large coal reserves doubles the population value of a region. (I have given the reasons for this deduction in *Environment and Race,* page 321.) For the rest one may divide the agricultural areas, and also the desert areas, into six equal portions. The pastoral areas differ so greatly in value that only a first approximation can be arrived at in dividing them into six equally endowed regions. In Fig. 11 I show the broader classification of lands according to their utility. If anything, Queensland has not been given quite enough credit for her potential central agricultural lands.

It is very difficult to arrange the boundary so that the new "West Australia" and the new "South Australia" shall get enough good pastoral lands. This is because a very small portion in the "good pastoral belt" (*i.e.,* east of line AB) is as good as a very large portion in the "poor pastoral belt." However, Wa + Wp + Wd shows the suggested allocation of agricultural (a), pastoral (p), and desert (d) lands to the new "West Australia." Only in the far north is there good cattle country, and there is no good sheep country available (as reference to Figs. 8 and 9 will show).

So also Sa + Sp + Sd is the allocation to "South Australia." By including some of the good pastoral lands in the west end of Riverina, a fair amount of good pastoral land is made available for South Australia. (See Fig. 11.)

Tasmania and Central Victoria must be linked to form the chief part of "New Victoria." It has a good slice of the best pastoral land in the Riverina, and a correspondingly small portion of poor pastoral land. Its value is greatly increased by the Morwell coal. New South Wales, as it exists at present, is far too well endowed for equity. It is, therefore, deprived of its northern third, which is linked to portion of Queensland to form a new State, which is indicated by Xa + Xp + Xd in Fig. 12. So also Queensland is too highly endowed by Nature, and pieces have been

whittled off in the south, leaving it still a region as well endowed as Western Australia. The latter (of all the present States) is perhaps the one nearest to possessing one-sixth of the assets of Australia (excluding coal).

The above problem is perhaps mainly of academic interest, but it draws attention to the very great lack of balance exhibited between the south-east and north-west of Australia. The economic pole of Australia is probably Newcastle, with its rich coalfield. The "non-economic pole" is certainly the centre of the desert rectangle in the west of Australia.

The writer, indeed, before this has advocated an extension of the powers of the Commonwealth over the relatively negligible half of Australia. The poorly endowed State of South Australia has been glad to relinquish the Northern Territory. In Western Australia the East-West railway was built, and is maintained by the Commonwealth. The Kimberley region is practically identical with the Darwin area as regards environment. So also the Murchison region is of the same type, and differs in every respect from

Fig. 11.—An attempt to divide the Commonwealth into seven equally-endowed areas. The suffixes a, p, d refer to agricultural, pastoral, and desert land. The dense pastoral lands are east of A.B.

the rich temperate south-west corner of Western Australia, which has long been known to geographers by the convenient name of "Swanland."

The map shown in Fig. 12 gives the salient data as to these tropical or arid portions of Australia. As regards the central portion, one million square miles (one-third of Australia) contains only about 2,000 settlers, a very small proportion out of six million. It also feeds only about one-half of one per cent. of the sheep, and perhaps two per cent. of the cattle. It cannot be described as a valuable asset to any State, and may surely be referred to as "Australia Deserta."

This deserted portion includes the new political division called Central Australia, but excludes the only really valuable part of the former Northern Territory, the cattle lands of "Northern Australia."

As regards the naming of this region Northern Australia, the writer wishes to raise an emphatic protest against this absurd way of giving "directional" names to new territories. Such names as "*South* Australia" and "*Western* Australia" have been a curse to geographical

nomenclature for years. What does "South Australia" mean? It used to extend to Darwin, and even now, if one is speaking of the south coast of the continent, we have to be careful to mention that it is not South Australia unless it happens to be in the *middle third* of the south coast. "North Australia" is equally ambiguous. The writer strongly urges the euphonious name of *Darwinia* for the new territory north of 20° of latitude. It aptly describes the land centring in Darwin, and commemorates one of the greatest of Englishmen, who, moreover, spent a considerable period in surveying Australian waters. So also "Central Australia" is nearly as ambiguous. Why should not the best known tribe of Australian aborigines, the Arunta, be commemorated by naming the vicinity of their tribal lands after them? Two of the aboriginal tribes of ancient Britons, the Silures and the Ordovices, have given their names to two of the chief periods in geological history. This type of name is adopted by many modern geological surveys, both here and in America.

FIG. 12.—The dotted regions include those sparsely-settled or uninhabited areas which might perhaps better be administered by the Commonwealth. Ruled areas show future close settlement.

In the following Table I give the approximate figures for the inhabitants and stock in these suggested Federal lands:—

SUGGESTED FEDERAL REGION

	Population.	Cattle.	Sheep.
"Darwinia"	3,000	450,000	—
Kimberleys	2,500	536,000	170,000
Murchison, etc.	10,000	150,000	2,000,000
Central area	2,000	260,000	450,000
Total	17,500	1,396,000	2,620,000

The total area is about 54 per cent. of the continent, and comprises about 1,600,000 square miles. The boundary might run from Shark Bay to Zanthus, and thence to the east along latitude 31°S. The East-West railway and the Port Augusta-Alice Springs railway (the two chief public works, and both constructed by the Commonwealth) would thus be included in the suggested Federal area.

We can now arrive at some conclusions as to the relative value of the States as they are. Agricultural and Industrial populations must always outnumber pastoral populations. Since all the coal and hydro-electric power occurs in the agricultural lands, it is obvious that the main value of the State lands depends on agriculture, and, therefore, on rainfall. This relation has been emphasised by stating that our Governments are not leasing land so much as rainfall to the settlers. The following Table is based on measurements of the lands suitable for (a) Close Settlement in Temperate lands; (b) in Tropical lands; (c) Good Pastoral lands; (d) Fair to Poor Pastoral lands; (e) Unused Desert lands. The figures, given in thousand square miles, are naturally only approximate:—

POTENTIAL VALUE OF THE STATES

		Close Settlement.		Pastoral.			
State.	Order.	Temp.	Tropical.	Good.	Fair to Poor.	Desert.	Total.
Queensland	1	134	100	367	69	—	670
N.S.W.	2	188	—	77	45	—	310
West. Australia	3	150	—	140	240	446	976
Victoria	4	68	—	10	10	—	88
South Australia	5	60	—	50	160	110	380
Tasmania	6	16	—	5	5	—	26
N. Territory	7	—	—	130	260	130	520
Total		616	100	779	789	686	2,970
Percentage		21	3	26	27	23	100

Three States (Queensland, N.S.W. and W.A.) have about equal amounts of fair temperate farming land. Queensland, however, has, in addition, her fertile tropical lands along the east coast. Hence this State is likely to take the lead, especially as her pastoral lands are vastly greater than those of New South Wales. In the distant future, the coal of Sydney may balance the tropical agriculture of Queensland. The 700,000 square miles of arid lands in Western Australia hardly enter into the question.

In the second rank come Victoria and South Australia. In agriculture they are about equal. South Australia has more pastoral lands (mostly of a poor type), but Victoria has really abundant coal at Morwell. Her rainfall is more uniform, and, therefore, she will probably always surpass South Australia. The arid 270,000 square miles in the latter State are unimportant. Tasmania is too small to enter into competition with the other States. Much of her south-west coast is so bleak that there is hardly a settler there. Even so, her restricted agricultural land is good, and her 26,000 square miles are of much more use to the Commonwealth than the 520,000 square miles of the Northern Territory.

A few words may be said as to the economic status of Australia as a whole. In agriculture she ranks at present only with small regions like Japan (18 million acres) and Roumania (15 million acres). But while these lands are intensively tilled, our agriculture, as stated, is sporadic at present. As regards pastoral products, Australia only ranks ninth among the cattle countries of the world. In sheep she leads the world with 93 million; while Russia has about 67, U.S.A. 41, and Argentine 36. In

regard to mineral production, Broken Hill is one of the greatest mines in the world, and Australia ranks third as regards lead, and produces the second amount of zinc. She is fourth in gold, and fifth in silver. In coal, Newcastle is the eleventh field in the world, a fine position; but U.S.A. has nearly 25 times, Canada 8 times, and China 6 times as much coal. However, Australian reserves are not far behind those of Britain.

I have in various memoirs attempted to compare Australia with Europe and U.S.A. In my recent book, *Environment and Race*, a method of graphical analysis seems to show that the resources of the United States of America are of much the same value as those of the disunited states of Europe. This result gives an approximation to the relative standards of living in Europe and U.S.A., for the respective populations are much about the proportion of 4 to 1. My deductions give Australia an economic value between one-fifth and one-seventh of U.S.A. Her industrial importance can never approach that of U.S.A. For instance, our best iron deposit (at Iron Knob) could not supply the present iron plants of U.S.A. during two years. Her total agricultural land is approximately one-quarter of that of U.S.A., but her best farming lands (with over 40 inches of uniform rain) are only about one-tenth as extensive. It is in this latter type of country that the dense population of eastern U.S.A. dwells.

To sum up, we may say that we can support 20 millions of people at about the present saturation (or standard) of the United States, or about 80 millions at the standard of Europe. This population will be so distributed that about 99 per cent. of the people will live in the south-east half of Australia, as is indicated in Fig. 10.

This distribution is, of course, indicated by the present population, and a thorough *quantitative study of the reasons underlying present settlement* is the best guide to the distribution of future settlement. This, indeed, is the study which has engaged the writer for a quarter of a century, and he feels that the Australian public is at last beginning to realise that such research has more than an academic interest, and that modern geography is one of the most powerful aids to the successful occupation of the lands of the Commonwealth.

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Physiographic Notes on some of the British Solomon Islands

(Advance Summary)

By G. A. STANLEY, B.Sc.
(Demonstrator in Geography, University of Sydney).

INTRODUCTION

A Journey to the British Solomon Islands.—In July, 1927, the writer was granted three months' leave of absence from the University of Sydney, in order to go to Rennell Island in the British Solomon Islands. The object of the journey was to make a geological reconnaissance of the island on behalf of the Administration of the Protectorate.

Acknowledgements.—The following advance summary of the investigations which were made during the visit has been prepared, and is published with the permission of the High Commissioner of the Western Pacific, and also of the Administration of the British Solomon Islands. Acknowledgements must be made of hospitality, advice and assistance tendered to the writer by Government officials, planters, missionaries and traders, and other residents of the group too numerous to particularise.

Scope of the Observations.—Leaving Sydney on the 20th July, 1927, the writer proceeded to Tulagi accompanied by Mr. H. Hogbin, B.A., (Anthropologist, University of Sydney), and Mr. N. Wilson (Wireless

Operator and Field Assistant). At Tulagi the Government had made arrangements for the transport of the party to Rennell, attaching to it a strong body of police under the command of Mr. E. Dudley-Davis. The expedition left Tulagi in H.M.C.Y. *Ranadi,* and proceeded to Rennell via Aola (on Guadalcanar), Maru Bay, Wanoni Bay, Kira Kira (on San Cristoval), and Santa Anna. At Rennell exploratory work occupied two months. On returning to Tulagi in October, the writer spent a week visiting the Russell Islands, Savo and the north coast of Guadalcanar as the guest of Mr. Pinching, of Lever's Pacific Plantations Ltd., in the schooner *Miro.*

The following summary, therefore, represents a compilation of many scattered observations made at various times and places throughout a period of nearly four months, and it is confined entirely to the so-called eastern Solomons. (See Map.)

The Physiographic Investigation of Islands in the Coral Seas.—Special interest attaches to physiographic observations among the high islands of the Pacific. The coral-reef problem still remains unsolved, and is still one of the major problems of modern geology. The powerful attempt which has been made by W. M. Davis during the last decade to revive the Darwin-Dana Subsidence theory has stimulated interest in the problem, and has done much to clarify its present status. But the counter theories which have been advanced by R. A. Daly and T. Wayland Vaughan are so well-considered, and so well-founded, that it cannot be said that the problem has been settled one way or the other.

The geologist cannot profitably study a sea-level coral reef. There are no sections to be observed, and no direct evidence as to its structure and the probable form of the basement on which it rests can be obtained. In the case of an elevated reef, the position of the geologist is much stronger. Erosion bares small sections, which, after being pieced together by ordinary geological methods, allow the structure and nature of the basement to be interpreted. In the case of sea-level reefs, therefore, the geologist must turn to a consideration of the physiographic history of the land masses with which the reefs are associated. The history of each particular mass must be studied, and any interpretation of the origin and history of the reefs must take into account the origin and history of the nearby lands. From such considerations, it is possible to give an interpretation which has a reasonable probability of being correct.

Here it is no longer sufficient to proceed by such empirical rules as that which has been familiar to mariners since the days of Dampier—that deep water faces steep land; in other words, that the submarine slope of a land mass is the continuation of its above-water profile. W. M. Davis has long recognised the complexity of the problems before physiographers in this connection, and in a series of classic studies has analysed the various coral-reef theories, and has subjected each to certain critical tests. Furthermore, a series of inductive studies has been published, for almost purely theoretical cases, in which known physiographic processes have been applied to hypothetical islands under all sorts of conditions. As a result of all this work, the physiographer who sets out to investigate the lands of the coral

seas is already armed with a reasoned knowledge of the problem before entering the field. He knows what observations to make, and what physiographic tests to apply to the observed topographic facts when he gets there. At a glance he is able to recognise the signs of complex coastal movements and oscillations.

Davis has recently pointed out that the present known facts have been worked over to their limit. Since the time of Darwin the accounts of early voyages, and the data contained in Admiralty charts, have been scanned over and over. What is now required are new facts. The work of Davis himself—both in the field and in the study—has shown how these new facts should be collected and analysed along physiographic lines. More than any living man, Davis has done much to stimulate interest in the coral-reef problem.

PREVIOUS LITERATURE

There is practically no information available about the detailed geology of the Solomons. It is true that Guppy [1] has written an entire book on the subject, but though this is a magnificent pioneer contribution, it is long out of date. Such great advances have been made in geological science, particularly in petrology and tectonics, that Guppy's work must be gone over again, and his conclusions (especially) reviewed in the light of modern knowledge.

As far as is known, no work has been done since Guppy's day. Nor have collections of rocks been made. The rocks collected by the writer have been supplemented by some collected by Mr. S. G. C. Knibbs (Crown Surveyor), which, through the writer, have been donated to the Department of Geology, University of Sydney. It is hoped that when the present paper is published in full, it will include an account of the petrology of these rocks. [2]

PHYSIOGRAPHIC OBSERVATIONS

Tulagi, Makambo and Gavutu.—The seat of the Administration of the Protectorate is situated on the small island of Tulagi, which, with Makambo, Gavutu and others, forms part of a small archipelago scattered along the western side of the larger island of Florida—or Gela, as it is usually called. The islands are well dissected, and are deeply embayed. They are not barrier-reef-encircled, though fringing reefs are well developed in places.

Tulagi, Makambo and Gavutu are each composed of part of a well-bedded, clastic volcanic series, comprising agglomerates, tuffs, and a white, so-called, "soapstone." The series is unfossiliferous. On Tulagi the rocks strike N.45°W., and dip to the south-westward at angles of 20°-30°. Small faults are common, as, for example, in the cutting through the hill between the Government Store and the Club, and in the raised cliffs near

[1] H. B. Guppy: *The Solomon Islands: Their Geology*, &c. London, 1887.

[2] These rocks include granites from the Shortland Islands, highly fossiliferous limestones from the same locality, and altered volcanic rocks from Florida Island.

the store of W. R. Carpenter and Co. These rocks weather to a dark red soil. On Gavutu, signs of contemporaneous contortion were observed in the soapstone. The writer did not visit Florida.

The three islands are well cliffed. There is clear evidence of recent elevation in the shape of a wave-cut notch around their margins, this being 6-10ft. above high tide level.

Savo.—This island, between Tulagi and the Russell Islands, is a fine example of a recent volcano standing in deep water of 400-500 fathoms. Its height is 1,800ft., and it has the form of a flattened cone. It is said that the Spaniards saw the island in eruption.

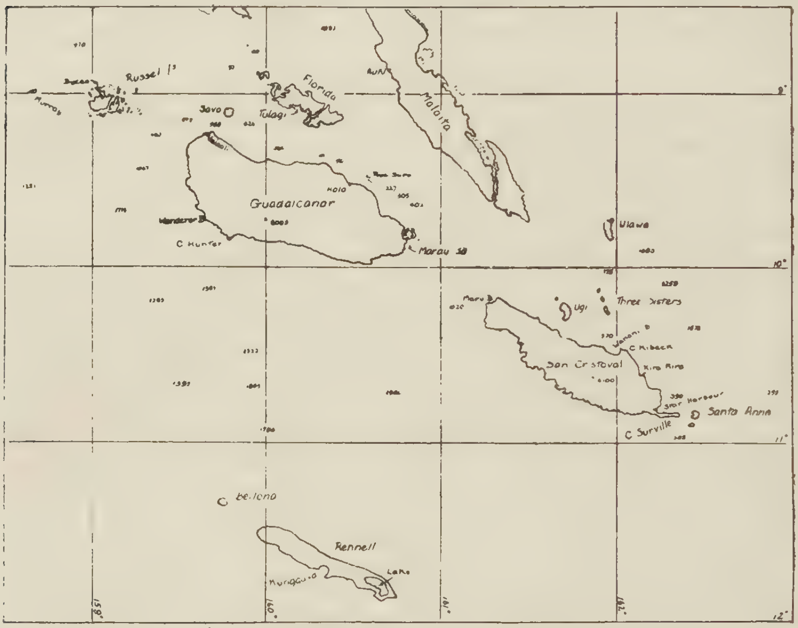


FIG. 1.—Sketch map of the south-eastern portion of the Solomon Islands, showing the localities described. The position and coastline of Rennell and Bellona are approximate only. Soundings are shown in fathoms. Heights in feet.

Savo is well dissected on all sides, the streams being more or less straight torrents, their gravelly beds, viewed from the sea, having the appearance of white roads leading inland. Around the margin are cliffs, which in places are now above the reach of wave attack, and, in consequence, they are vegetated and subdued in profile. From a passing steamer it might be thought that the island is uncliffed. Hot springs are developed in several places around the base. One which the writer visited is in the bed of a creek. Cold water flowing down-stream passes over a hot place in the bed, with great ebullition and formation of steam-clouds. The ground around is hot, and the soil is yellowish. In holes scooped in the ground, the natives

cook food. The rocks collected on Savo have not yet been examined closely. One appears to be a hornblende andesite, while another, curiously enough, has a metamorphic appearance.

The Russell Islands (known also as Pavuvu or Cape Marsh).—These islands lie to the westward of Savo. It seems that the high islands are formed of volcanic materials. Whether these volcanics are part of a series, or whether they are a dissected volcanic cone, is not known. Probably the former condition obtains. Around the flanks of the high islands (1,600 feet high) are limestones up to at least 150ft. Other islands to the eastward and northward of the two main islands are formed of elevated limestone also. It is suggested that these represent a raised barrier reef which has suffered abrasion.

The raised reefs presumably rest unconformably on the volcanics. Embedded in the limestone of Bycee Island were discovered rounded pebbles of an andesitic lava. These pebbles have yet to be examined petrologically. Around Bycee Island three distinct wave-cut notches show in the limestone cliffs. These cliffs are fronted by a narrow abrasion platform elevated about 4ft. above high-water mark. On the face of the abrasion platform corals are growing luxuriantly.

Guadalcanar (also known as Solomon).—This great island is a little more than 80 miles long, has a maximum breadth of about 30 miles, and a maximum height of over 8,000ft. The coast is very imperfectly surveyed, and the interior is mostly unexplored. The writer passed along the north-west end and the northern coastline by sea, but landed at only one or two points.

In general, it may be said that the island is asymmetrical, the highest ranges being situated to the westward. In consequence, the southern coastline is steep-to, embayed, and faces deep water, thus being a region of dominant subsidence. The northern coastline, on the contrary, is formed by an undulating coastal plain of varying width, is linear and not embayed, and faces relatively shallow water, thus being a region of dominant recent elevation. The island appears, as a whole, to have undergone a tilting movement about its longer axis, which runs W.N.W.-E.S.E.—upward in the east and downward in the west.

At Aola, behind the Government Station, subdued sea-cliffs occur on the inner edge of a lowland area which is being brought under cultivation. This flat is not much more than 10ft. above the sea. Along this section of the coast the foothills of the main ranges appear to rise from the coastal plain in terraces. One flat truncated-cone-like terrace with radial gullies suggests by its form recent volcanic action. It is suggested that the northern portion of Guadalcanar has been affected by the recent vulcanicity, of which Savo is a part. The main backbone of the island further south may be mainly plutonics and metamorphics.

The grassland hill-country at the north end of Guadalcanar around Lavoro, Maravovo and Veisali shows magnificent dissection into steep gullies and comb-ridges.

As far as is known, coral reefs are but sparsely developed around Guadalcanar. They are not to be expected along the northern coastline

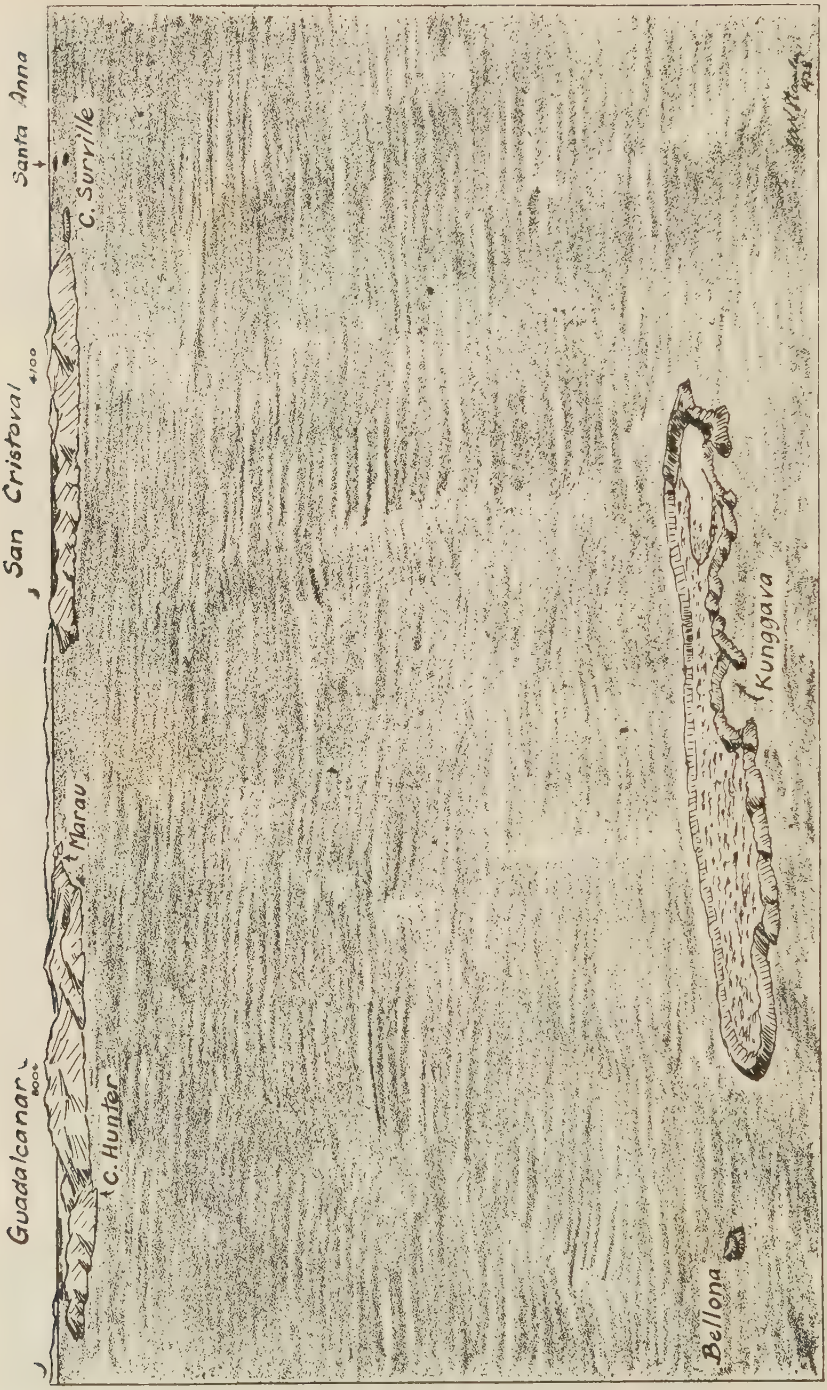


FIG. 2.—Block diagram of Rennell Island, looking north-eastwards towards the high islands of the Solomons.

owing to the recent elevation, and where many great rivers pour quantities of silt into a relatively shallow sea. Along the west coast, however, northward of Wanderer Bay, the writer understands that barrier reefs are developed.

Around Marau Sound at the south end of the islands, drowning is strikingly apparent in the many embayed islands which are developed there.

San Cristoval (also known as Bauro, but more commonly as Makira). —This island is nearly 80 miles long, with a maximum width of about 20 miles, and a maximum height of over 4,000ft. Like Guadalcanar, the long axis trends W.N.W.-E.S.E.

Here the asymmetry of Guadalcanar is not so apparent. The south coast is described as bold, steep-to and embayed. Along much of the north coast a coastal plain is absent, or else very restricted. Guppy describes the rocks in general as diorites, gabbros, and altered dolerites. Between Cape Kibeck and Star Harbour the coast is bold and embayed; nevertheless, Guppy found limestones on the hill-sides raised at least 500ft. Northward of Cape Kibeck similar limestones are found rising on the hill-slopes beyond the coastal plain. The limestones appear to rest unconformably upon volcanic rocks. They are absent along the south coast.

It would thus appear that San Cristoval, like Guadalcanar, had been affected by a tilting movement about its longer axis.

Santa Anna.—This small island near the south-east end of San Cristoval is of very great interest, for it was described in detail by Guppy, who states that this was the island with which he was most familiar, and which he took most pains to examine. The writer visited the island for but half an hour or so on a wet day. But Mr. Wilson subsequently spent about three weeks there late in the year.

The island represents a small raised atoll through which, at the summit (520 feet), projects portion of a nucleus of volcanic rocks. This hilly portion is situated to the windward side. The crescent shape of the old reef is still very apparent, and the old lagoon, enclosed by the elevated horns of the crescent directed to leeward, is now occupied by two shallow, brackish lakes. Around the margin of the raised island is a well-developed, luxuriant fringing reef, which around Port Mary shows a distinct tendency to re-develop the former crescentic disposition of the atoll.

Mr. Wilson was able to confirm Guppy's observations that volcanic pebbles are embedded *in situ* in the raised limestones, and also that the volcanic nucleus projects through the limestone at the summit. In the cliffs around the island the writer and Mr. Wilson observed a well-marked, wave-cut notch about 5 feet above high-water mark.

Rennell Island.—This island, the main object of the writer's visit to the Solomons, is situated to the south-westward of the main trend line through San Cristoval and Guadalcanar, being distant from the former about 100 miles. (See Fig. 2.)

Rennell Island is probably the finest example in the world of a raised atoll. As such, it is of very considerable geological interest, and would form one of the finest places to be visited by a fully-equipped scientific

expedition having as its object the investigation of the vexed question of the origin of oceanic atolls. Formerly a great, annular, sea-level coral reef enclosing a central lagoon, it has after elevation preserved its general outline. At present it has the form of a long, narrow dish—the interior is depressed, and is surrounded by a rim, the outer side of which forms the steep-to coastline.

The island is about 50 miles long, and varies in width between 6 and 12 (?) miles. The long axis trends W.N.W.-E.S.E., the trend being continued in the small raised atoll of Bellona. From a distance the island is remarkable for its long, low, uniform profile. The shore-line is steep-to, and is fronted by a narrow barrier-reef which is remarkable for the narrowness of its lagoon. It is, nevertheless, a true barrier reef, though in places it passes into a fringing reef. Behind the reefs the shore-line consists for the most part of bluish-grey and white limestone cliffs. Occasionally there are white sand beaches. Behind the immediate shore-line the land rises steeply. Native tracks to the interior usually lead to a lower gap in the rim, so that though the average height of the rim may be 400-500ft., the interior may be gained in places by a climb of but a couple of hundred feet. The ascent is not uniformly steep. The tectonic history of Rennell has not been simple, and in places on the outer side of the rim, there are still relics of an elevated barrier reef, behind which is an elevated lagoon. In climbing the rim, then, the first steep rise is over the old barrier reef; then follows a descent into a hollow representing the lagoon; then comes a longer and steeper climb up the main mass of the rim.

In general, once the summit is reached a more gentle descent is commenced into the great central depression. The top of the rim is not level. There are low gaps and higher peaks. In many places it is extremely narrow, being only a few feet wide, knife-edged and jagged. Elsewhere it is much broader. Exposed as it is to the full force of the weather, it is everywhere much fissured. The ragged limestone pinnacles of the rim are quite the most difficult part of the island to traverse.

The central depression represents the one-time lagoon of the atoll. As a whole, the island has been tilted so that the south-east end of the depression is occupied by an extensive, brackish lake. The surface of this lake is about 70 feet above sea-level. The western end of the lake is constituted by a maze of swamps, islands and winding waterways, while the eastern end is almost devoid of islands. The reason for this is to be found in the tilting movement which the island has undergone. The floor of the central depression is not flat. There are hills and ridges in it, some of which rise at least 100ft. above the general level. Owing to the tilting the lake is deepest at the south-east end. There it washes directly against the inner face of the rim, having submerged all minor undulations on the lagoon floor. To the westward it shallows, and between the lake shore and the rim is a gradually widening coastal plain. At first only the highest ridges of the lagoon floor appear above the water as isolated islands; gradually these increase in number; and finally the waters of the lake merge imperceptibly through a maze of swamps and low hills into the undulating floor of the central depression.

Geologically, then, the island is formed entirely of raised limestone. No outcrop of volcanic rock was discovered, nor is such known to the natives. If such existed, it would surely have been used for the making of stone artefacts. Some stone tools *do* exist, however, but they are obtained as rounded pebbles which are found embedded in the limestone not far above the present sea-level. The natives know these well. The writer collected pebbles embedded *in situ* in the limestone on the shore of Kunggava Bay. Also many hones were purchased from the natives, who invariably indicated the source of supply. These pebbles and artefacts have not yet been examined petrologically. All appear to be volcanic, with the exception of one, which appears to be metamorphic.

Weathering of the limestone produces all the features of karst topography. As a whole, the island is buried beneath a dense rain-forest. This combination of an execrable surface and jungle renders exploratory work both tedious and fatiguing. Caverns and sink-holes are common, and from these supplies of drinking water are sometimes obtainable.

The natives are of mixed Polynesian type. They are still almost untouched by white influence, the island having been left alone by missionaries, traders and the Government alike.

THE SOLOMON ISLANDS AND THE CORAL-REEF PROBLEM

As has been indicated in the introduction, the investigation of the coral-reef problem is best made along physiographic lines. It now remains to be seen how the above observations of the writer bear upon it.

In the first place, it may be said that the islands seen vary from reef-free, volcanic cones like Savo, through high, embayed, and reef-encircled islands like the Russell Islands, to huge mountainous earth-blocks like Guadalcanar and San Cristoval. On the other hand, there are raised atolls like Santa Anna and Rennell.

Savo is evidently in the stage where it is still being cliffed, and where the loose, cobbly nature of the offshore deposits do not allow of the formation of coral reefs.

The Russell Islands have long passed this stage. They have evidently subsided, and a barrier reef has been developed. The pebbles of volcanic rocks found in the limestone of Bycee Island indicate that denudation of the volcanic island was going on during reef-formation.[1] Subsequent elevation of the Russell Islands has raised the old barrier reef and the fringing reefs which were associated with it.

Guadalcanar and San Cristoval represent two great earth-blocks which form important units in the earth-plan of the Pacific. Their physiographic

[1] It should be pointed out that Guppy has recorded such occurrences of pebbles in raised limestones from many localities. He also states (*Ibid.*: p. 24) that volcanic rocks were transported by floating trees to the coral islets of Rua Sura, near Aola on the north coast of Guadalcanar. However this may be, the volcanic pebbles in the Bycee Island limestone point indubitably to the volcanic nature of those portions of the high islands which rise above the investing limestones.

history has been a complicated one, and it is not to be unravelled merely by sailing along the shoreline and making sketches. Nevertheless, the writer suggests that there is evidence of a period of submergence, which has been followed by a differential elevation along one side of the block, while the other side either stood still or subsided. In the case of Guadalcanar, the elevation of the northern coast was sufficiently great to lay bare a wide coastal plain, and to produce a long, linear coastline. In the case of the northern coast of San Cristoval, elevation has not been so great as to obliterate all traces of the earlier embayments. The coastal plain is not so wide as in Guadalcanar, while in places it is lacking. At the same time, the raised limestones of Cape Kibeck testify to the elevation.

Santa Anna represents yet a more advanced stage. The volcanic pebbles in the limestone there, which were first recorded by Guppy and were recently seen by Wilson, testify to the proximity of a volcanic nucleus. Further search reveals this core outcropping at the summit of the highest ridge, on the windward side of the island. The latest movement has been one of elevation.

Rennell is still further advanced. Here volcanic pebbles alone give evidence of the proximity of a volcanic island. [1] The last movement again has been one of pronounced elevation. Subsequent denudation has failed to reveal, as far as is known, the nucleus of volcanic rock or other rocks, which, in all probability, form the base of the Rennell atoll.

Thus there appears to be a definite sequence of island development, in which submergence, followed by emergence, are the dominant movements. Submergence may have been partial or complete. Savo is almost too new to have participated in anything but the latest phases of emergence. The Russell Islands were strongly submerged before emerging. Santa Anna was all-but submerged. Rennell was completely submerged. These movements controlled the history of the reefs associated with the land masses.

CONCLUSIONS

The writer's work on the Queensland coast has led him to reject the Subsidence theory—at least in the form which was given to it by Darwin himself—as being able to explain the origin of the Great Barrier Reef. It is, therefore, with great pleasure that he is able to maintain that the above sequence of island development, which appears to hold good for those members of the Solomons which were seen, is entirely in accord with the Subsidence theory. Rennell Island, not long ago an oceanic atoll like the Indispensable Reef to the south of it, must have been developed on a subsiding foundation entirely as Darwin supposed.

The studies of Guppy in the Solomon Islands led him to reject the Subsidence theory. His interpretation of the development of Santa Anna seems, to the writer, to be more easily explained by the Subsidence theory.

[1] The reader must clearly differentiate between a volcanic island like Savo—in which the form and geological composition of the island is the result of the activities of a volcanic cone or a group of cones—and an island formed of volcanic rocks—like Tulagi or Gavutu, or San Cristoval (in part), or many of the islands of the Queensland coast between Gladstone and Bowen. The latter significance is used in the present case.

The strong embayments of San Cristoval point to subsidence of that island, which is so very close to Santa Anna. The subsidence was so well marked, that it has not been masked by the later considerable movement of elevation which has affected the northern coastline.

The writer is of the opinion that when Guppy's work comes to be examined again, his inferences will have to be rejected. His pioneer observations were carefully made, and will ever remain as a model of the good work that can be done under the most trying conditions. On re-visiting the scene of the work, one cannot but admire the spirit of the man, who, hampered by ill-health and the uncertainties of treacherous natives, and in an enervating climate, accomplished so much, not in geology alone, but in botany, zoology and anthropology. At the same time, the inferences which he drew from his observations must be subjected to the closest scrutiny. It may be that they will have to be modified, or else abandoned and a new interpretation attempted, which will be in accord with the greater knowledge available at the present day.

AN ABORIGINAL PETROGLYPH

Recently a small schoolboy, playing at sunset, noticed the very complete figure of a kangaroo reproduced herewith. The writer passed over the rock at another season of the day, and the carving was not easily re-discovered. The grooving is very evenly executed but shallow, and only the horizontal rays of the sun pick out the design.

The small map shows the locality; the kangaroo is at X, 300 paces up the bush track from the junction of the Killara Creek with the Lane Cove River, a little below the De Burgh Bridge (B).

K = Killara Railway Station.

L = Lindfield Railway Station.

D.R.T.

The Age of the Earth [1]

By L. A. COTTON, M.A., D.Sc.
(Professor of Geology, University of Sydney).

Mother Earth has long guarded the secret of her age with a reticence even more pronounced than that exhibited by the most artful of her human children. But the searchings of man amongst the tablets of stone have at last revealed a chronology of events in her history which reveals the long-kept secret.

Just as the natural curiosity of children with respect to the age of their parents leads to many guesses, so students of geological history have in the past ventured many estimates of the age of the Earth.

In this lecture, a passing reference to some of the conclusions is given, followed by a more explicit account of the most reliable method of investigation and its results.

An early result of geological study was the explanation of the origin of the sedimentary rocks. These have been built up, layer upon layer, by deposits of sediment swept down by rivers into the sea or lakes. There is thus a constant transfer of rock material from the land to the sea. The two processes of erosion (the wearing down of the lands) and sedimentation are thus complementary in character.

Studies have been made in many lands on the rate of erosion, and the quantitative aspect of this process is now known with a considerable degree of accuracy. It has been estimated that for the whole earth, the average rate of erosion is about one foot in 9,000 years. There is naturally a great variation in the rate of erosion in different districts.

It is also possible in many cases to find where the sediments are being deposited, as, for example, in the upbuilding of a delta deposit; and a knowledge of the relative areas of erosion and sedimentation enables an estimate to be made of the rate at which sediments are being built up at the present day.

The results of such an investigation may then be applied to the great thicknesses of sedimentary rocks which have accumulated throughout geological time, and hence some estimate of the time required for their building may be made. Such studies have yielded variable results, ranging from one hundred million to six hundred million years for the earth's age.

Another method of enquiry was attempted by Lord Kelvin. This was based on the assumption that the earth was originally a molten globe, and that it has gradually cooled to its present state, which is revealed by the downward increase in temperature encountered in deep bores and mines.

[1] Substance of lecture given to Society on September 14, 1927.

Using certain physical measurements with regard to the capacity of rocks for transmitting heat, Lord Kelvin calculated that the age of the earth must lie within the limits of from twenty million to one hundred million years.

This estimate, however, was made before anything was known of the existence of radio-active minerals in the rocks of the earth, or of their capacity for generating heat; and these recent discoveries naturally render obsolete the conclusions of Lord Kelvin.

Another method is based upon the salinity of the oceans. The assumption is made that the water of the oceans was originally condensed from the atmosphere, and was consequently quite fresh; and that its present salinity is due to the continuous contributions of salts carried into it in solution by river waters throughout geological time. As the amount of common salt carried into the sea by rivers per annum and the total amount of salt in the ocean are both fairly well known, the age of the oceans can be readily calculated. An age of from sixty to one hundred million years is indicated by this method.

It has, however, been shown that the estimates previously considered are liable to a large error, because of the assumption that the geological process of erosion has been uniform throughout geological time: for it has now been shown that in the earlier stages of geological history, the rate of erosion was much less than that which operates to-day. In consequence of this error, the estimates of geological time so far considered may require to be multiplied by a large factor to bring them into harmony with recent advances in knowledge.

At last, however, a reliable method for estimating geological age has been found. It is based upon the behaviour of the radio-active minerals, and upon such discoveries as have been made during the present century.

The study of uranium and thorium bearing minerals, has revealed the remarkable fact that these are unstable, and that they are constantly breaking down to form a series of new elements, of which radium is one member. One ultimate product of disintegration is lead, and another is the gas helium.

The study of the physical properties of these new elements has enabled their rate of disintegration to be measured.

Hence it is now possible, by making a chemical analysis for the amounts of uranium, thorium and lead present in certain rocks, to calculate the time occupied in the process of change, and hence the age of the rocks themselves. The conclusions are remarkable, and the results of age determinations in rocks of the same geological period in different continents have shown such a notable degree of concordance, that it is now possible,

with a great degree of confidence, to draw up the table of geological time which follows:—

AGE IN MILLIONS OF YEARS

Era.	Duration.	Age to Beginning of Era.
Quaternary	1.5	1.5
Cainozoic or Tertiary	58.5	60
Mesozoic	140	200
Palæozoic	400	600
Proterozoic	400	1,000
Archæozoic	400	1,400

One of the most notable features of the geological record is the presence of rhythms marked by the recurrence of similar rocks in the sedimentary record.

These rhythms may be of short duration, such as the "varve" sediments, which represent seasonal variations, or they may represent longer climatic cycles, such as the Bruckner cycle in rainfall, having a period of about 35 years.

Or again, the period of the rhythm may be of great duration, such as may be correlated with the astronomical cycle of precessional changes, which has a period of about 21,000 years. By far the most striking cycle known is the great glacial cycle which has left clear records in the rocks of the Proterozoic, Palæozoic and Quaternary eras, and for which the most probable explanation is to be sought for in the changes in the sun's radiation of heat.

In the vast span of geological time now revealed by the study of the radio-active minerals, geologists and geographers may find ample scope for the explanation of those changes in the Face of Nature which are made clear by their studies.

A TRIBUTE TO PROFESSOR GRIFFITH TAYLOR.

By DAVID G. STEAD

(President, Naturalists' Society of New South Wales).

Just as we are going to Press, word comes officially that our worthy President, Professor Griffith Taylor, has been offered, and has decided to accept, a post as Professor of Geography in the greatest geographical school in the world—at Chicago. Sensible as we must be to the recognition of the worth of our greatest of Australian geographers—and one of two or three (in the writer's estimation) of the greatest geographers of any period—it affords but poor consolation, I think, when one considers the loss which Australia is to suffer through the Professor's removal. To the lover of Science for Science's sake in our native land, as well as to him who sees the immense economic benefit to be derived from our studies, it is little short of heart-breaking to think that our distinguished investigators can be allowed to find conditions so much better elsewhere as to necessitate their consideration of offers such as that which our President has received.

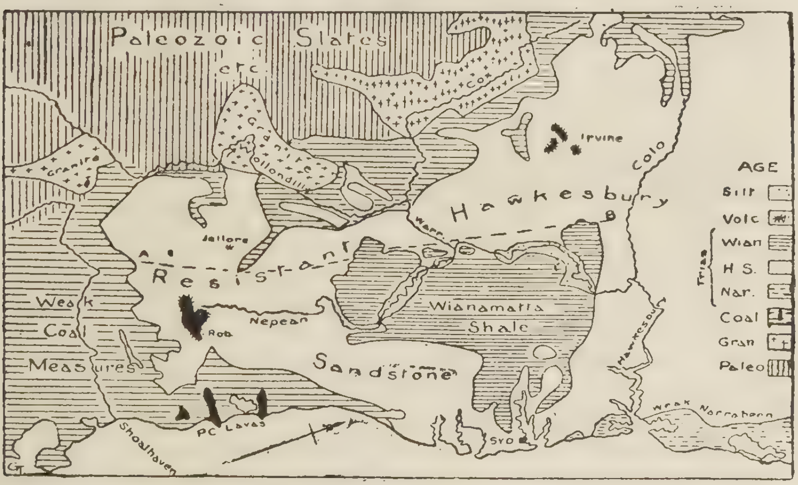
Griffith Taylor has, by his earnest endeavour and enthusiastic labours, done much to lift the science of geography to the great position which it

(Continued on page 49.)

The Distribution of Vegetation in the Sydney Region

By H. W. HAMILTON, B.Sc.
(Lecturer, Teachers' Training College, Sydney).

The region extends from the Hawkesbury River on the north, to Bulli and Cataract River on the south, and from the Pacific Ocean on the east, to the Blue Plateau on the west. The well-marked features of the Sydney Region are: (1) The Tidal Zone, (2) The Shore Line, (3) The Sand Dune country, (4) The Hawkesbury Sandstone country, (5) The Wianamatta Shale country, (6) The River and Swamp lands, (7) The Illawarra country, with Coal Measures. In each of these divisions is found a characteristic vegetation, and this vegetation is an expression of the different environmental conditions found there.



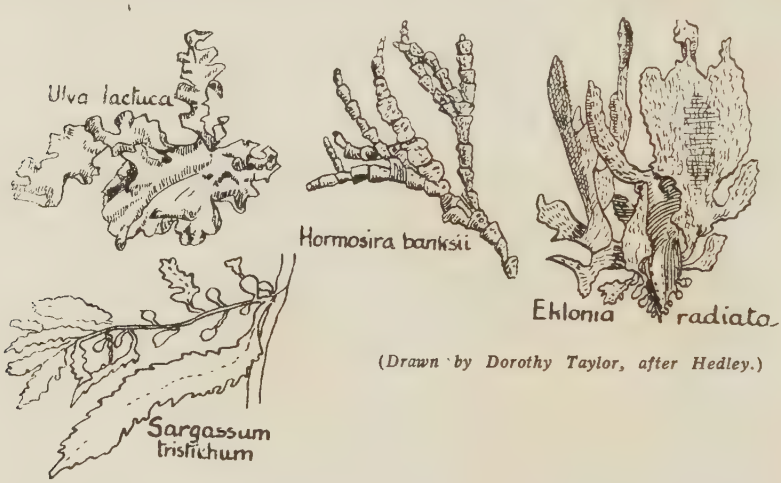
Geological (Edaphic) control of vegetation near Sydney. The Illawarra "Brush" occurs alongside the arrow.

(From Roy. Soc., N.S.W., 1923.)

Vegetation of the Tidal Zone.—In this zone we have varying conditions due to the movement and varying depth of the water, and here we find a group of plants admirably adapted to the varied environment. The plants found here are known as sea-weeds. They belong to the group called algæ. They are easily divided by their characteristic colour into three groups: (a) The green weeds found fringing the tidal zone, where they are exposed to light and air for long periods. *Ulva*

lactuca, the Sea Lettuce, is an example of this group. (b) The brown weeds are members of a group found in between the tide limits. They are alternately submerged and exposed, and live in the beat of the surf, hence they are tough and leathery in texture. *Hormosira, Eklonia* and *Sargassum* are common examples of this group. (c) The red weeds are found in rock pools and below the high-tide limit; usually they are not exposed, but are entirely submerged throughout their existence. *Nemalion* and *Polysiphonia* are examples of the red weeds.

The Shore Line.—Above the Tidal Zone on the landward side stretches the Shore Line. A characteristic vegetation is found here. An interesting group of plants known as Halophytes (salt-loving plants) grows along the Shore Line. Amongst these are found *Cakile maritima, Atriplex* (sp.), *Salsola kali* and *Suæda maritima.* Another plant found on the Shore Line is *Pelargonium australe,* a native Pelargonium of halophytic habit. A Correa, (*C. alba*) is also a denizen of the Shore Line.

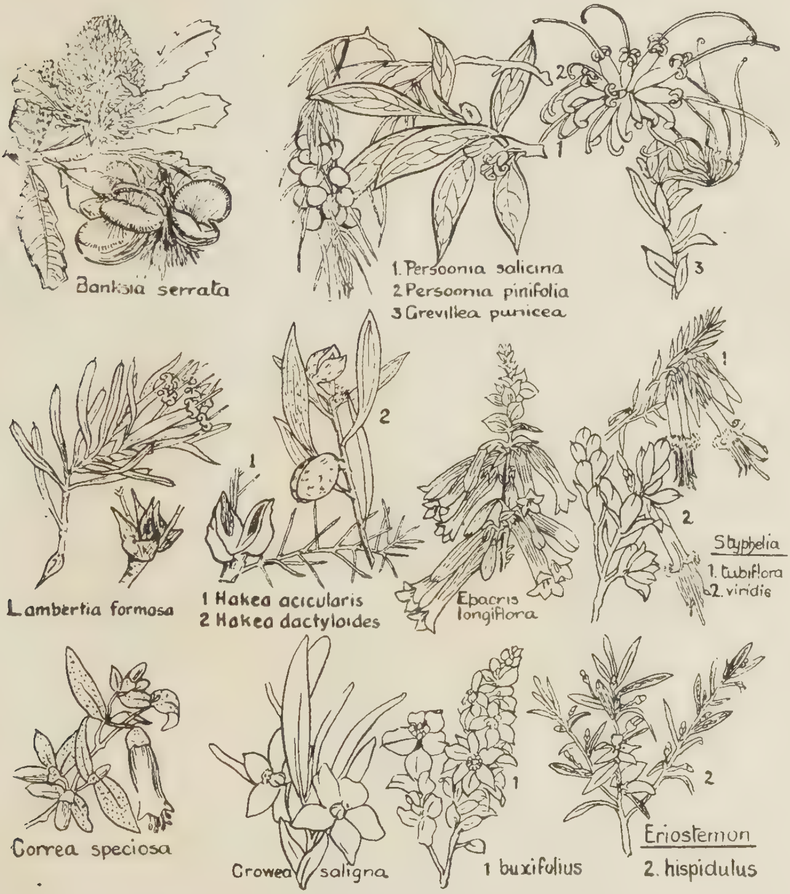


(*Drawn by Dorothy Taylor, after Hedley.*)

The Sand Dune Country.—Fringing the Shore Line on the sandy beaches there is often found a stretch of dune country. The dunes move inshore in a north-westerly direction, driven by the south-east and south winds. Here conditions for plant life are very hard, and on the windward side of the dune country only very hardy types can persist. Amongst the plants found here are two hardy grasses *Spinifex hirsuta* and *Festuca littoralis.* These play an important part in arresting the wandering sand. Sedges and rushes are also found in patches and a Portulaca, *Mesembryanthemum australe.* In sheltered positions and on the fixed dunes vegetation is much more profuse. Banksia, Casuarina, Acacia, Correa and Leptospermum (Tea-trees) are found with an undergrowth of sedges and grasses. The shrubs in this region are dwarfed and stunted in growth as a result of the action of the wind.

The Hawkesbury Sandstone Country.—The vegetation here is largely xerophytic in character. The Hawkesbury sandstone weathers to

a hungry, barren soil, and the plants which grow in that soil are, as a rule, stunted and fitted up in such a manner that the loss of water by transpiration is reduced to a minimum. Reduced leaf surface, hairy leaves, sunken stomata, thick cutin are well-marked features of these xerophytic plants. Though the Hawkesbury sandstone is very barren, it is densely populated with plant growth. The plants may here be grouped in a



Common flowers of the Hawkesbury Sandstone Country.

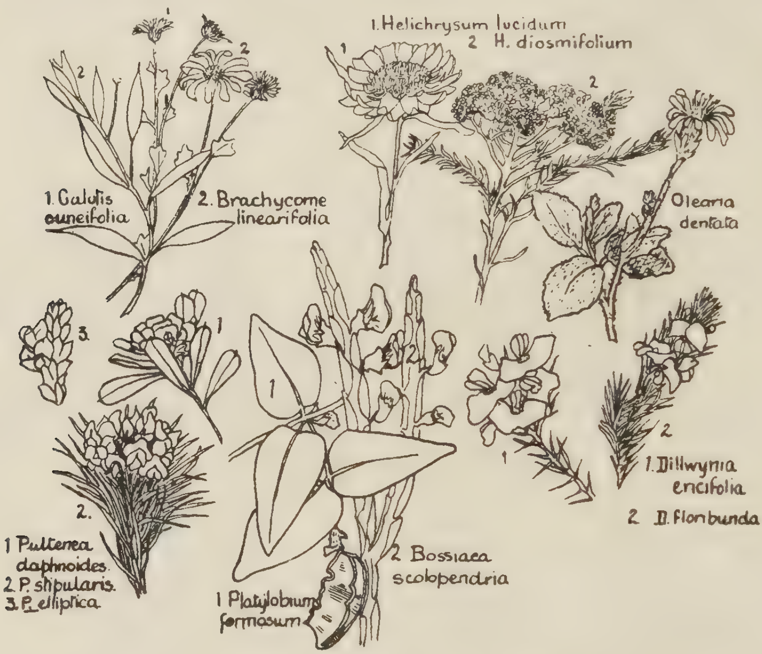
(Wild flower illustrations drawn by Dorothy Taylor, after Sulman, "Wild Flowers of N.S.W.")

general way under the heads of (a) trees, (b) shrubs. There is a profusion of flowering shrubs. Amongst the trees we find Eucalypts predominating. Amongst these Eucalypts grow forms ranging from trees to mallee-like shrubs. Conspicuous members are *Eucalyptus micrantha* or Scribbly Gum, a smooth-barked type; *E. corymbosa* or Bloodwood, a scaly-barked type; *E. robusta* or Swamp Mahogany; *E. eugenioides*, the Stringy Bark; *E. piperita*, the Sydney Peppermint, with medium fibrous bark;

E. botryoides or Woolly-butt, with flaky bark; and *E. sieberiana*, the Sydney Ash. Where conditions of growth are hard, mallee-like Eucalyptus trees are found forming scrubs, as on the fixed dunes at La Perouse. *E. virgata* and its variety *E. obtusifolia*, are commonly found in such localities.

Trees attaining a fair size are found in the Angophoras. *A. lanceolata* is quite a large tree, while *A. cordifolia* is a shrub. Acacia is fairly commonly found. *Acacia longifolia* grows to a tree in sheltered positions.

Characteristic plant families of the Hawkesbury Sandstone are: (a) The Proteaceæ, exemplified by the *Banksias* (called Honeysuckles), Geebungs (*Persoonia*), the wooden Pear (*Xylomelum pyriforme*), the Spider Flowers (*Grevillea*), the Needle Bushes (*Hakea*), the Waratah (*Telopea*)



Common Flowers of the Hawkesbury Sandstone Country.

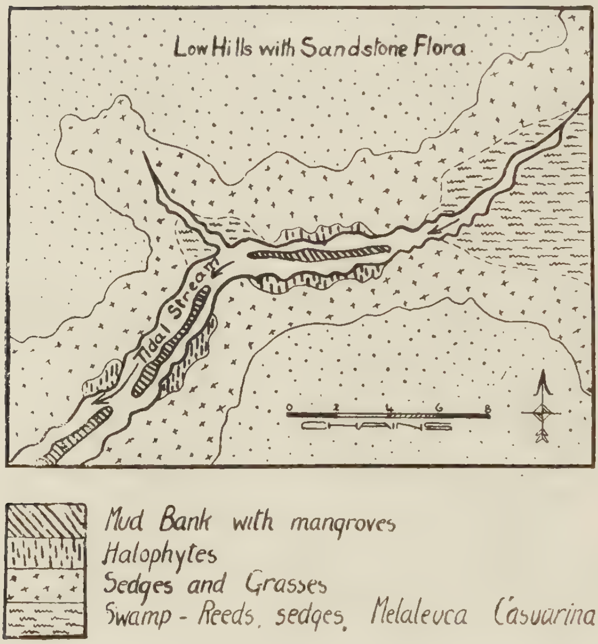
and the Honey Flower (*Lambertia formosa*). (b) The Epacrids or Heaths, some of which are called Native Fuchsias, are common. *Epacris longiflora* is a type commonly found. In this group, too, we have the *Styphelia*, called "Five-Corners," and the *Astroloma*, or Ground-Berries. (c) The Rutaceæ. The well-known *Genera Boronia, Correa, Eriostemon* and *Phebalium* are conspicuous members of the Rutaceæ. (d) Acacia. Amongst these are found the Myrtle Wattle (*A. myrtifolia*), the Sweet-Scented Wattle (*A. suaveolens*), the Port Jackson Wattle (*A. discolor*), the Juniper Wattle (*A. juniperina*). (e) The Myrtaceæ. *Eucalypts Angophora, Callistemon, Calythrix* and *Darwinia* are examples of the Myrtaceæ, which abound on the Hawkesbury Sandstone. (f) The Compositæ.

Numerous daisies are found in this group. *Calotis, Brachycome, Helichrysum* and *Senecio* being most conspicuous. (g) The Leguminosæ. This group is represented by a very large number of plants. *Viminaria, Pultenea, Platylobium, Bossiæa, Hovea, Dillwynia* and *Indigofera* are representatives. Amongst other plants found on the sandstone country are *Casuarina* (She-Oak), Christmas Bush (*Ceratopetalum gummiferum*), *Callicoma* (Black "Wattle"), *Exocarpus* or Native Cherry, the Port Jackson Pine (*Callitris cupressiformis*), and *Podocarpus*, one of the Taxacea, is known as the Berry Pine, since the seeds are borne on a fleshy receptacle resembling a berry. *Macrozamia spiralis* is common in some localities on the sandstone; it is one of the Cycadaceæ. Orchids: two great groups, terrestrial and epiphytal, are also common, as are various members of the Iris family, such as *Patersonia;* the Lily family, as *Xanthorrhea* (Grass Trees); and *Smilax*. Christmas Bells (*Blandfordia*), *Stypandra* and *Thysanotus* (Fringed Violet) are found on the sandstone; while amongst the Amaryllis group are found *Doryanthes excelsa*, a conspicuous plant known as the "Gigantic Lily" or Gymea, and *Crinum pedunculatum*. This very general description of the Hawkesbury Sandstone vegetation emphasises the fact that it is most profuse.

Five types of Leptospermum common on the Wianamatta Shale
1 L flavescens 2 L scoparium 3 L laevigatum 4 L stellatum 5 L lanigerum

The Wianamatta Shale.—The vegetation of this zone of country consists, in the main, of open forest with grassed undulating land. The principal trees are Eucalyptus, Angophora, Melaleuca and Casuarina. Wattles (*Acacia*) are also commonly found. Amongst the Eucalyptus family the following representative types grow to a considerable size. Smooth barks: Blue Gum (*Eucalyptus saligna*), White Gum (*E. hæmastoma*) and the Spotted Gum (*E. maculata*). Half barks (a type of Mountain Ash): (*E. sieberiana*), Blackbutt (*E. pilularis*) and Grey Box (*E. hemiphloia*). Rough barks: Ironbark and Stringybark. The Casuarina is found dotted along the water courses, and in low-lying, damp tracts of land. Tea-trees (*Leptospermum*) are also fairly numerous. *Bursaria spinosa* and Bracken Fern are fairly frequent, the former in some cases being a nuisance to the grazier.

The River and Swamp Lands.—These have a vegetation of which some members are restricted to very definite areas. In the tidal river region mud banks fringe the water, which are alternately submerged and exposed by the rise and fall of the tide. Here grow Mangroves (*Avicennia* and *Aegiceras*), plants admirably adapted to life in this saturated, salty mud. Next to the mud banks we find à halophytic zone occupied by types such as Salt Bush and *Suæda maritima;* next there is a zone of sedges and rushes, then grass, and a gradual change to the flora of the sandstone flanking the river. In the swamps we find a characteristic vegetation of sedges and rushes with other plants, such as the Sundew (*Drosera*), fringing the swamps; these are succeeded by aquatic plants such as *Jussiæa, Ottelia, Myriophyllum* and *Vallisneria.*



Sketch map of a tidal stream (an arm of Oatley Bay), showing distribution of vegetation.

The Illawarra Country with the Coal Measures.—Here is a very varied flora which, in exposed places, is very similar to that of the Hawkesbury Sandstone; but where shelter and soil conditions are favourable we find the characteristic brush or Malayan flora, a distinctive vegetative feature. The soil in the brush country is rich, being formed as a result of erosion due to water action. The coastal scarp forms a shelter to plants, and thus we have ideal conditions for plant growth which results in that "exuberant expression of vegetable vitality" known as the "Brush." Features of this brush are the number of trees (soft woods in the main), creepers, and the undergrowth of ferns, mosses and epiphytes which luxuriate in the damp, shady shelter of the brush land. Amongst the trees are found *Ficus* (three species)—the large-leaved, the small-leaved, and the

rough-leaved respectively. The Lilli-Pilli (*Eugenia smithii*) the Brush Cherry (*Eugenia myrtifolia*), the Myrtle (*Backhousia myrtifolia*), the Gigantic Nettle (*Laportea gigas*), Sassafras (*Doryphora*), the Candelabra tree (*Panax*), of which there are three species. In the brush proper there are few Eucalyptus trees, but the allied Turpentine (*Syncarpia laurifolia*) is a hardwood that is found here. Amongst the palms in the outskirts of the brush, the Cabbage Tree Palm (*Livistonia australis*) grows luxuriantly and in large numbers, whilst occasional plants of the Bangalow Palm are to be found. The Coachwood Tree (*Ceratopetalum apetalum*) is a conspicuous denizen of the brush. The under brush consists, in the main, of ferns and mosses. Tree-ferns (*Dicksonia* and *Alsophila*) are beautiful and conspicuous members of the flora. *Adiantum, Davallia* and *Pteris* are other ferns which flourish in the moist shelter of the brush trees. Creepers also are conspicuous. The Native Grape Vine, of which there are three species (*Vitis antarctica, V. hypoglauca* and *V. clematideæ*) runs riot over the trees, forming festoons which give a characteristic appearance to the brush landscape. *Lyonsia, Clematis* and a Native Passion Vine (*Passiflora banksii*) are also creepers commonly found in the brush. Epiphytal orchids and ferns add to the beauty of the brush; amongst the latter are the Bird's Nest fern (*Asplenium nidus*) and the Staghorn fern.

A Tribute to Professor Griffith Taylor.

(Continued from page 42.)

now occupies everywhere in the world; while, so far as our own continent is concerned, he has created an open book for all to read, out of what was previously a subject cloaked in mystery, misunderstanding and misrepresentation. His published papers on various aspects of Australian Geography are legion, and a number of his works are of great and outstanding importance and merit. His latest work of moment—the book *Environment and Race*—is a veritable *magnum opus*, and has caused the greatest interest to be shown in geographical circles everywhere. Speaking of this, the great American geographer, Ellsworth Huntington (writing in the *New York Saturday Review*) says: "Professor Griffith Taylor, leading Australian geographer and Antarctic traveller, is one of the few men who are pre-eminently originators of new ideas. Whatever he touches assumes an unusual aspect . . . . it displays an extraordinary ability to summarise a vast amount of knowledge in a few paragraphs . . . . Taylor often seems to be wrong—even his best friends think so—but he is a prophet, and we who criticise are likely to find that in many cases it is we, not he, who are wrong."

Coming to the everyday practical application of Professor Taylor's work to the development of our economic life in Australia, I feel constrained to repeat a sentence or two of what I was privileged to write in a published study of his latest book some little time back: "With a gathered fund of information about our country, its climates and rainfall, habitability and possibilities in stock and food-crop production—a fund unrivalled in Australia—Taylor has consistently shown us the way to a sane development of our land. Because he has told us the truth, and has

(Continued on page 62.)

The Illawarra Scarp at Stanwell Park [1]

By HAZEL BREWSTER, B.Sc., and AGNES CALDWELL, B.Sc.

Stanwell Park, a small coastal township in the County of Cumberland, is situated 34 miles from Sydney on the South Coast railway line. The marked recession of the Illawarra Scarp at this point is of particular interest. An investigation and an attempt at an explanation of this will be the purpose of this paper. The area surveyed was about a mile and a half in a north-south direction, and a mile and a half inland.

We wish to thank Professor Taylor for his valuable assistance in the writing of this paper. We also acknowledge the use of L. F. Harper's Geological Map of the Helensburgh-Bulli District, published in the

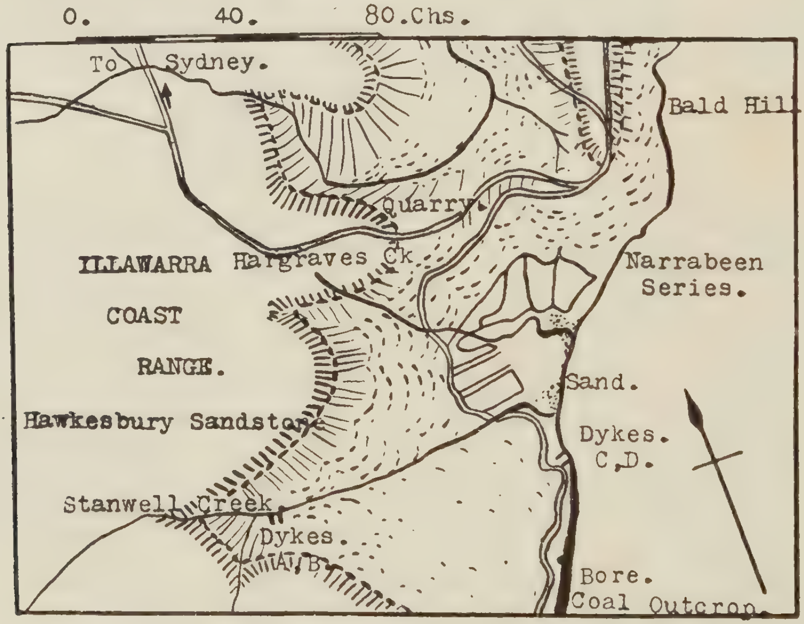


FIG. 1.—Geological Map of Stanwell Park.

Department of Mines *Geology and Mineral Resources of the Southern Coal-field*, Part I., 1915; though Harper gives no contours or heights of the district. For the early history of the area we are indebted to P. J. Carrick, of Clifton.

Geology.—(i.) The Hawkesbury Sandstone is only found as a capping of about 15 feet on Bald Hill at 750 feet, and on the peneplain level and southern headland. This presents sheer cliff faces typical of the

[1] Abstract of paper given at the meeting on November 10, 1927.

series. (ii.) Extending from the Hawkesbury series to sea-level are soft Narrabeen beds, characterised by a persistent chocolate shale horizon, containing scales of copper, shown in the railway cuttings. Much conglomerate interbedded in the shales is very prevalent. (iii.) In the southern headland the underlying coal measures outcrop at 1-2 feet above sea-level, and dip in a generally northerly direction. They are actually below sea-level at Stanwell Park itself. (iv.) Four dykes occur, two halfway up Stanwell Creek, suggesting an explanation for the greater recession of the scarp. Two others occur in the southern headland, the greater being 75 feet high; 5½ feet at the head of the dyke, widening to 10 feet at the entrance, extending 70 feet inwards. The smaller is a little to the north, being only 5 feet wide, 30 feet long and 15 feet high. (v.) Two sills occur in the northern headland (see block diagram). One is at sea-level, and extends to a small island, about 50 yards out to sea; the other is situated about 35 feet up the cliff face to the north of the first, and caps the larger residual standing up from the rock platform.

Topography.—The Illawarra Scarp gradually rises from Botany Bay, reaching a maximum of about 2,000 feet behind Nowra. As far south as Stanwell Park precipitous sandstone cliffs flank the shore, and the whole coast-line is marked by the absence of beaches. Further south the softer

Fig. 2.—Stanwell Park from the Station.

coal measures outcrop, and the scarp recedes, till at Bulli the coastal plain is 2 miles wide. A marked recession occurs at Stanwell Park, a satisfactory explanation of which is difficult to find. The general line of the scarp recedes about ¾ mile, but Stanwell Creek penetrates this line for a further ½ mile.

Description of the Block Diagram.—Stanwell Park consists of two valleys, the steep V-shaped valley of Stanwell Creek, and the newer and less eroded one of Hargraves' Creek, separated by a low spur. The valleys are hemmed in by the Illawarra Scarp of 800 feet at the cliff edge, rising to 900-1,000 feet within a mile westward, and spurs capped with Hawkesbury Sandstone at 750-800 feet, form the headlands to north and south. On the east is the sea, which the two creeks enter by lagoons. Sand dunes and rocky islands flank the shores. Dykes and sills penetrate the headlands. The northern boundary of the Park has been attacked by the Port Hacking river on the northern side, until it is now a very striking ridge only about

40-50 feet wide. The Port Hacking river rises on the scarp at 850 feet, and gradually drops 100 or more feet into a typically juvenile gorge, continuing its eastward direction till joined by tributaries at Bald Hill, where it flows north.

Peneplain Surface.—At Stanwell Park it is 800 feet high, with a slight rise to the west; a badly drained reed and scrub country. A few miles back is the main road, crossing Madden's Plains, as the plateau here is called.

Rivers.—(i.) Stanwell Creek, the most important in the Park, rises in the catchment area of the dam, the overflow crossing a broad platform for some 400 feet. The stream descends in a succession of falls and pools, and nearer sea-level its valley gradually broadens, and traces of an old ox-bow lake remain. The creek then flows into a small lagoon, with intermittent connection with the sea. (ii.) Hargraves' Creek, like Stanwell

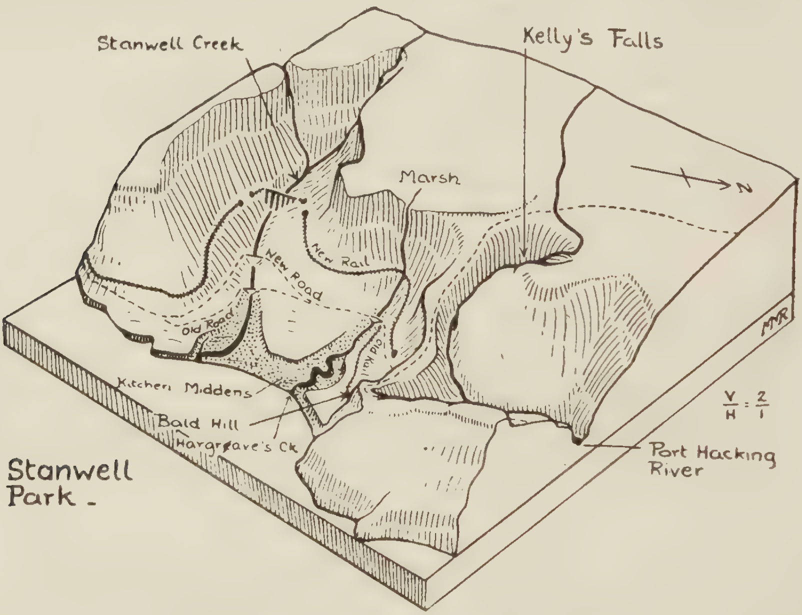


FIG. 3.—Block diagram of Stanwell Park area.
(*Drawn by Mildred Raymond.*)

Creek, rises in a marsh on the peneplain, descending rapidly from 700 feet to 200 feet, after which it broadens out, meandering to the sea which it enters by a winding lagoon somewhat larger than at the mouth of Stanwell Creek. The stream receives many tributaries from the slopes of Bald Hill, dry most of the year. (iii.) *The Port Hacking River* rises on the peneplain, and flows north-east as a senile stream. After crossing the main South Coast road to Sydney, the river descends in cascades to Kelly's Falls, a drop of some hundred feet. The river now flows in a deep ravine in a south-east direction, changing to the east. The stream frequently bifurcates owing to obstructions brought down by floods; further down are river terraces. On nearing the railway line, the stream takes a general

northerly trend, and flows quite slowly with very little grade where sand-pits have been built up. The fact that the Port Hacking River is so near the sea at Stanwell Park, and yet travels 10 miles north before entering the sea at Port Hacking, is proof that it flowed in this direction prior to the uplift. The Port Hacking River receives tributaries from Bald Hill, and these, in conjunction with those on the south side, will be the chief factor in capture and reversal of the Port Hacking River.

Imminent Captures at Bald Hill.—Bald Hill stands out as the sentinel of the Park, capped with resistent Hawkesbury Sandstone to the extent of 10-20 feet; the slopes are otherwise gently undulating towards north, east and south, though the seaward slopes terminate in abrupt truncated headlands. Bald Hill is connected to the main scarp by means of a narrow ridge which separates the deep valley of the Port Hacking River from the deeper eroded valley known as Stanwell Park. On all sides small streams are at work; some to enter either the Port Hacking River or Hargraves' Creek, others to fall over the cliffs in small waterfalls. Two of these were noted, their normal course coming to an abrupt end at 50 feet. On approaching the hill proper, the forest growth gives place to a treeless, grass-covered slope, the few stunted trees which have survived being bent in the direction of the prevailing south-east winds, but on the protected side trees appear once more. A similar feature is exhibited on the opposite headland, though not to so great an extent, since that promontory does not jut out so far, and, moreover, the scarp recession at Coalcliff has not been so acute. Thus it would appear that the dominant winds are the main factor in giving Bald Hill its characteristic appearance.

Marine Erosion.—The headlands of Stanwell Park provide an interesting study of marine erosion, particularly that to the north, though as yet in only an immature stage. Rock platforms exposed at low tide flank these cliffs, covered alternately with drifting sands or shingles or exposed by the dominant winds. Stacks and small rocky islands have been disrupted from the cliff face and rock platform, the best example being two residuals which stand up from the rocky platform. Various small rocky islands skirt the shores, but the best is composed of sill material, and is just beyond reach of the land, even at low tide. To the south of the residuals is a somewhat larger cove, probably due to the minor headlands being locally hardened by the intrusion of the sill at sea-level, so preventing any sapping on a large scale. The composition of the beach material in these coves varies from fine sand to coarse pebbles. The southern headland is in all essentials analogous to the northern on a small scale. To compensate for the intrusive sill material of the northern headland are two dykes, and this factor may help, in part, to explain the existence of the headlands. The same method of denudation is in operation, though the rate of coastal sapping is gradually increasing with the outcrop of the softer measures. The rocks of both points exhibit typical spheroidal and honeycomb weathering, and ripple marks are visible on the cliff faces.

Two lagoons, typical of the East Australian Coast, are found at Stanwell Park, indicating that formerly there were two small coves in place of the one big bay of to-day, but that the intermediate headland was of softer rock, though the same series, but not intruded and locally hardened

as in the northern and southern headlands. As the intermediate headland retreated, the two beaches coalesced, and the retreating headland was safe from any further attack by the waves, and acquired the more rounded form of the inland topography. The lagoon at the mouth of Hargraves' Creek is more meandering and picturesque than that of Stanwell, though

FIG. 4.—Stack in course of formation.

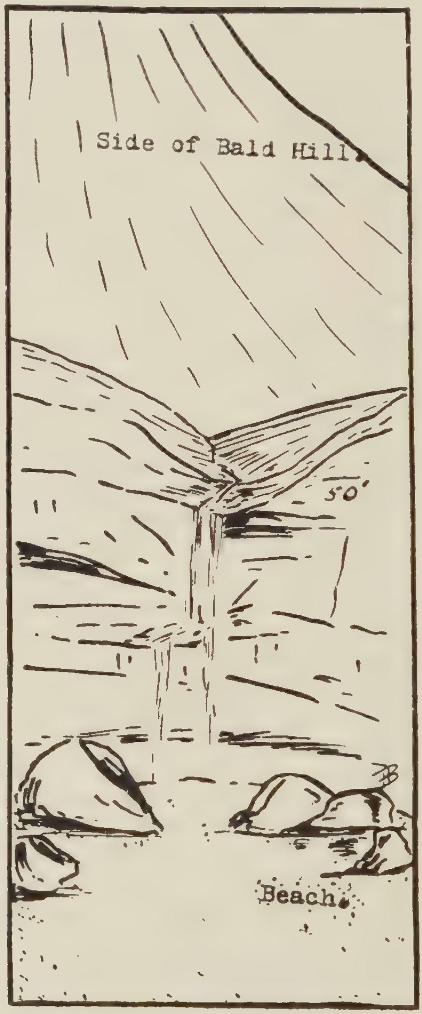


FIG. 5.—Small fall over the cliffs.

they are of practically the same size. Almost entirely blocking the course of Hargraves' lagoon to the sea is a huge moving sand dune, built by the dominant south and south-east winds. A little to the south is another dune, but this has become fixed, and was used by the aboriginals as a kitchen midden.

Recession of the Scarp.—At Stanwell Park the scarp recedes as elsewhere, but the striking feature is that the recession is considerably greater here, ¾ mile to the general line of the scarp, with a further recession of ½ mile up Stanwell Creek. The fact that the bays to the north are less pronounced is readily explained by the outcropping Hawkesbury Sandstone at sea-level, so that very little sapping is possible on the shales. With the appearance of the Narrabeen beds, small bays and coves appear. At Stanwell Park the whole Narrabeen series is exposed in the cliff face, and the still softer coal measures are just visible at sea-level, so that undercutting is very pronounced, and accounts for the greater recession. This explanation is scarcely sufficient on considering the notches made in the line of the escarpment farther south, for the coal measures outcropping are far more extensive.

The headlands all down this coast are penetrated by one or more dykes or sills, a factor which has probably determined their formation by locally hardening the adjacent rock, though once the basalt weathers it is a line of weakness. The Stanwell Park may be the result of the coalescing of two small coves, due to the relative difference in the durability of the intervening headland and the cutting back of the two creeks, Stanwell and Hargraves.

Stanwell Creek penetrates the lines of the scarp considerably more than Hargraves' Creek, having worn a deep valley; and whilst this may be due to the bigger flow of water, the river has been helped presumably by the following geological factors: Across the course of this creek two dykes reach the surface. These, on weathering, have naturally been a line of weakness, aiding the river in its work of destruction. In addition, there has been a certain amount of faulting; these faults have been discovered readily by numerous small streams which are gradually eating back and have hastened and augmented their erosive powers.

History.—Stanwell Park, comprising 1,000 acres, passed as a Crown Grant to Mathew J. Gibbon. The first building was erected by Sir Thomas Mitchell, a surveyor. The second building—Hillcrest—was erected by Mr. Ralph Hargraves, a son of Judge Hargraves.

The ownership of Stanwell Park passed from Gibbon to Hargraves, then to the North Bulli Coal and Iron Company, still later to H. Halloran. Subdivision followed, and further buildings have been erected during the last 15 years, there being to-day a heavy reserve price on unsold land.

Railways and Roads.—The first rail was built in 1884, following the 100-foot contour. To ensure better grades and escape the inconvenience of the old Otford Tunnel, a new double line was put down, descending from 350 feet to 150 feet in the Park. This necessitated the construction of one of the highest viaducts in Australia (across Stanwell Creek) and three tunnels. The old rail now has been converted into the new road.

The Area between Coalcliff and Clifton, N.S.W.

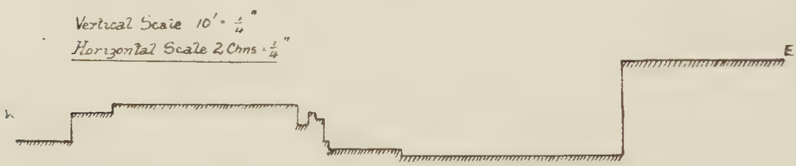
By R. V. STEWART, B.Sc., and A. R. MacINNES, B.A.

The area lies on the coast-line about 40 miles south of Sydney. It is part of the major uplift which has been termed the "Nepean Ramp," and it is possible that many of the features upon which we now remark are direct resultants of this uplifting force. Though only some six square miles in area, there are three main topographic features which may be discussed in their order of altitude.

There are three main series which outcrop: the Hawkesbury Sandstone, the Narrabeen Shales, and the Coalmeasures. The first of these is merely a capping, the second is much weaker, and prone to the forces of erosion, whilst the third has many hard bands of sandstone interbedded with shales and coalseams, which give a terraced effect along the exposed sea coast.

Throughout the area there are numerous faults which are best traceable in the coal seam as it is mined. The data from the levels of the mine workings have been of the utmost value when the surface features of the area are to be explained. For no great distance in any one direction does the seam extend unbrokenly. The frequency and size of the faults can be judged from the section (Fig. 1) which is taken due west in Coalcliff Colliery.

Fig 1



Section West-East Through Coal Cliff Colliery = Coal Seam.

One of the topographical features of great interest is the rock platform, and questions arising as to the method of its formation are rather controversial. In this area there are six rock platforms, of which space does not permit a detailed description here.

This series of rock platforms and interspacing bays can, we think, be correlated with topographic and geological features. The bays have all been started along some plane of weakness, either a fault, dyke or original re-entrant angle in the coast-line, and the rock platforms are the remains of headlands formed in the original coast-line as the areas between zones of weakness. The following points are primary importance in considering their formation:—(a) On account of individual peculiarities, each platform must be considered separately. (b) The platforms, excepting half of No. 5, are cut in sandstone. (c) The platforms are cut at different heights

above sea-level. (d) The sea action is not so vigorous on a platform or headland as in a bay (a factor dependent upon the region of maximum force in destruction of a wave, which appears to be after the wave has broken, not when it is merely moving). (e) There are two kinds of platform, *viz.*, the level and the dipping. (f) In all cases a weak stratum lies just above the platform level. This stratum is of shale or coal.

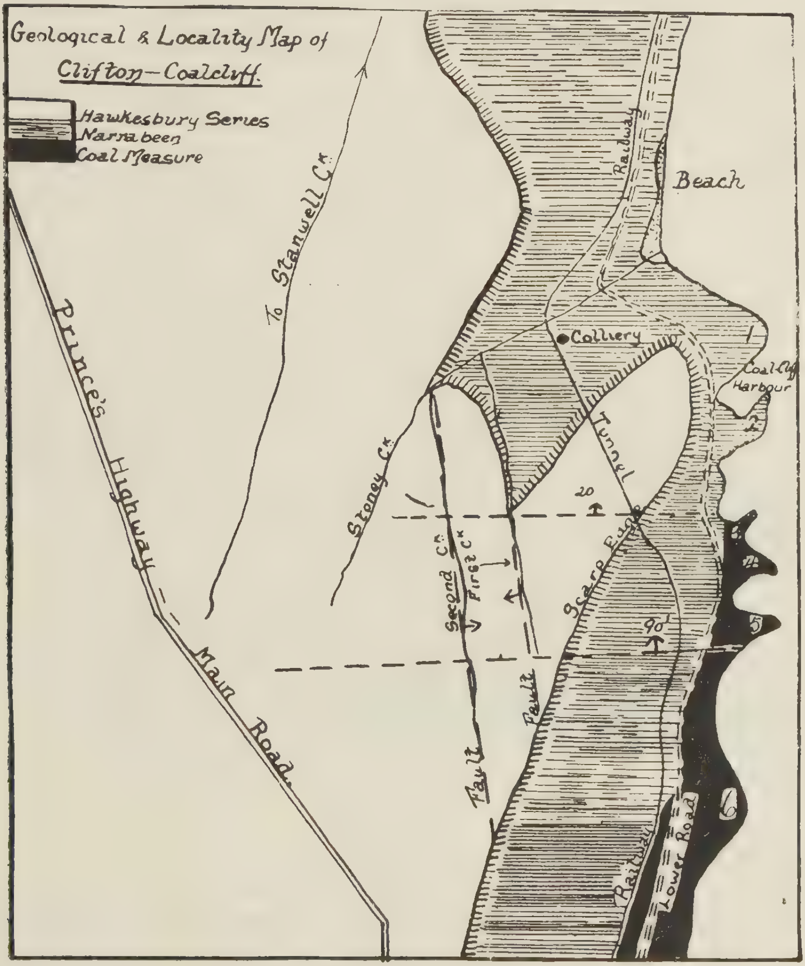


Fig. 2.—Geological and locality map of Clifton—Coal Cliff.

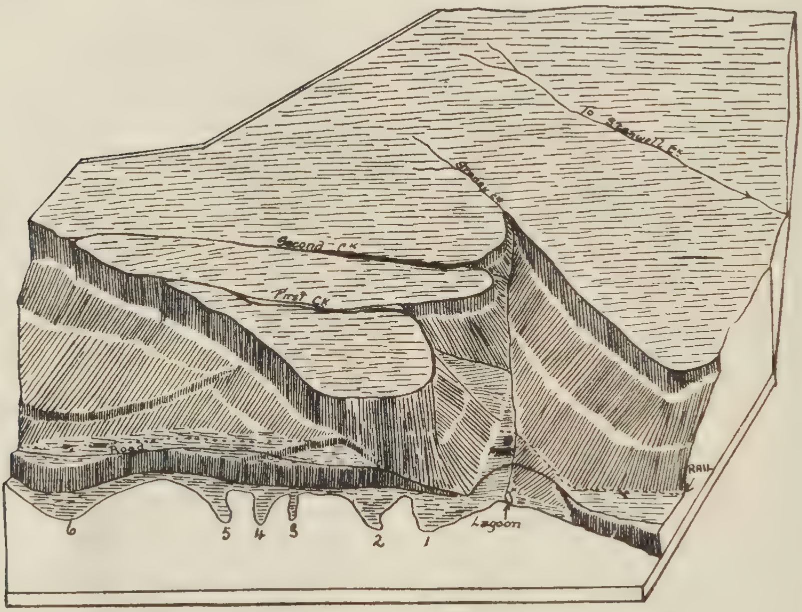
Hence, after considering the above evidence and confessing ignorance of the exact level at which a wave cuts a platform, we have come to the conclusion that, in all probability, the platforms have been cut along weak strata at or above sea-level, but not below the water, and probably

in their present position. Thus we suggest the evolution of the rock platforms in this area as follows:—

(1) A linear coast-line formed by a north-east-to-south-west fault. (2) Sea erosion along north-south faults and east-west dykes, and at shale outcrops. (3) Sea erosion of headlands horizontally along shale bands, thus producing an undermining of the cliffs and their recession at platform level. (4) A final stage of headlands eaten back to the general cliff face to form a general cliff coast with numerous rock platforms.

The next topographical feature of importance is the beginning of the coastal plain, which gradually widens until blocked by the lava flows

Block Diagram of the area Coal-Cliff -Clifton.



in the Kiama district. Actually the first signs occur at Stanwell Park and Coalcliff, but these are mere "bays." It is noticeable that a wide band of shale in the Narrabeen series is closely associated with this first appearance of the plain, and is possibly the local level at which sapping has taken place. Though here 300 feet high, the plain gradually descends, until at sea-level some miles south of the area, and so has descended along the upturned edges of the Newcastle-Bulli geo-syncline. The jointing also has a possible effect, and its interaction upon the factor of the fault coast-line may give a possible explanation of the formation of the plain.

The most apparent topographic feature (as can be easily traced on the block), is the marked parallelism of such features as stream beds and scarps. These exist in three series:—

(1) The north-south faults—first and second creeks. (2) The east-west faults. (3) The scarp behind Clifton, the scarp behind Coalcliff, and Stanwell Creek tributary.

First and second creeks are definitely associated with faults, and into this series we may introduce the coast-line. The latter, on account of its linear characteristics and sheer face, has evidently been caused by a north-south fault, whereas the creeks are in a position which the strike and dip of the two major faults shown in the accompanying section would expose as faults on the surface. The fault under first creek is 33 feet, and downthrown to the west. That under second creek is 22 feet, with a zone of fracture 1½ chains wide and upthrown on the western side in a series of four small fault blocks. Thus it would appear that the area between the two creeks is a trough or graben. These faults in their southern extremities cut the mountain side into two huge chines, which form deep gullies on the mountain side.

The east-west faults do not seem to affect the main drainage of the plateau surface to any great degree, and are best seen in the sections given by the cliff face and the small ravines on the mountain-side. The first is near platform 2, and on its upthrow side (south) we get the first appearance of the coal seams. The second, near platform 3, is 90 feet. The third, between platforms 5 and 6, is considerable, and makes a distinct cleft in the scarp. Another fault forms the southern edge of platform No. 1.

We would direct attention to the parallelism existing between the scarps and Stanwell Creek tributary. This does not seem to be in any way related to faulting, but apparently is the direct product of the jointing characteristic of the Hawkesbury sandstone. Thus the re-entrant angle forming the "bay" behind Coalcliff is quite probably the resultant action of the waters running in Stoney Creek and sapping acting in unison. The valley would then be widened according to the general principles involved, when very hard measures cap weaker strata.

Reference to the block diagram shows the upper surface of the plateau to have the general level appearance characteristic of the lacal late Tertiary peneplain. The flora is Xerophytic and peculiar to the sandstone country. It is quite a contrast to the Malayan jungle of those slopes which are protected from the west winds. Peat bogs and reed-covered plains are the chief and only noteworthy features of this upland.

Hence in this sector there is a complexity of faultings which have produced important topographic forms. Possibly these faults are directly related to the main faulting and uplift of the Illawarra coast-line, with the coast as the major fault and the others minor. We would thus have a wide zone of fracture, in which jointing and marine erosion have been effective agents.

Drifting Continents: The Wegener Hypothesis

By PROFESSOR SIR EDGEWORTH DAVID

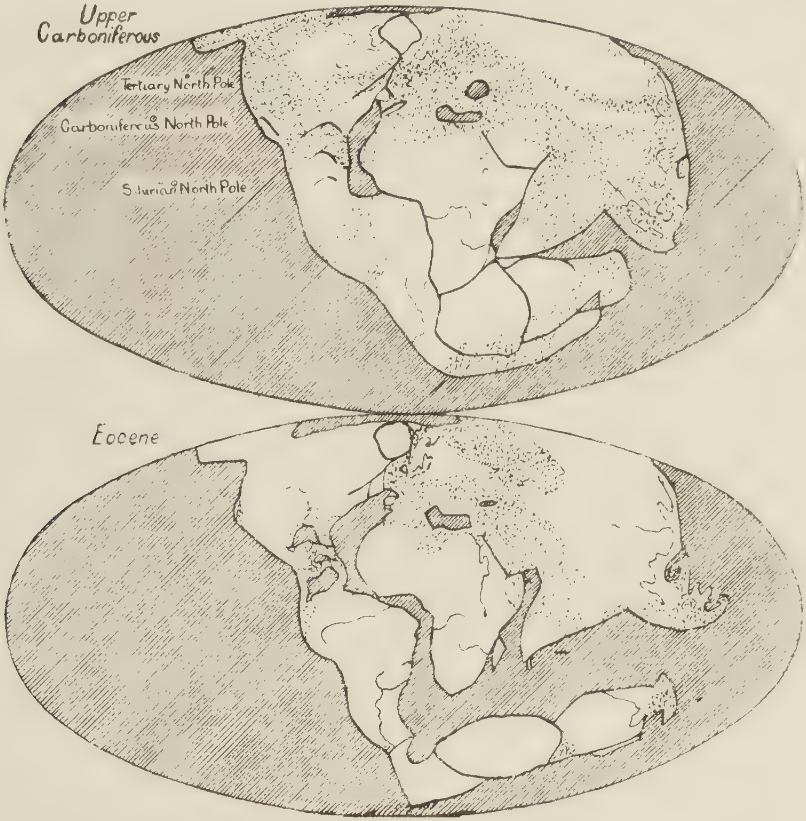
(Notes on the Address delivered on June 12, 1928)

The Wegener Hypothesis puts forward the probability that at one time the main bulk of that part of the earth emerging from the oceanic waters was *one* connected mass—the Pan Gea—and that no dismemberment into continents took place until the latter end of the Paleozoic Epoch. At that date a great rift was originated that developed into the Atlantic Ocean. Africa seems to have been stable. The sketches show the earlier continental drift, and the tendency to assume what we look upon as their present fixed relation towards one another. The whole theory appears fantastic at first sight, but a contemplation of the facts of science, as voiced by Sir Edgeworth David and shown in his slides, includes the hypothesis within the realm of probability. The great essential is that the present-day enquirer should grant the enormous periods of Time that have elapsed since the initiation of this movement and divergence of the continents, and Science has now a clock or time-piece for measuring those periods unknown to earlier geologists. This is the Radio-active method of calculation, based on the disintegration of Uranium to the final product, lead. Sir Ernest Rutherford claims it as much the most reliable means of arriving at the age of the rocks of the earth and as approximately correct.

Before one can deny Wegener's statement that the continents have moved, one must investigate the present-day state of affairs. Is the land stable and motionless, or does the whole or any part shift relatively to any other part? Evidence of instantaneous movements comes from Wellington (New Zealand) and from Tanna (New Hebrides). Regions liable to movement can be traced in two great lines across the globe, where both vertical and horizontal movement can be observed as the expression of stupendous forces acting on the less resistant portions of the crust of the earth. Yet other present-day movement can be traced as the result of the relief from the load of the ice sheets of the last Glacial Epoch. We may even deduce the thickness of the ice from the post-glacial recovery, taking the relative specific gravities of rocks and ice; this, of course, only if the movement is finished.

The effect of the Hume Reservoir will be to load the crust with a bulk of water three times the contents of Port Jackson, so a fine test of resultant movement of the crust can be carried out, with much more exact data than is sometimes the case. So much for vertical movement. Recent studies in the Swiss Alps reveal an amazing extent of horizontal movement in late geological time. The intense folding of these very young mountains has been theoretically straightened out, and there can be no other conclusion reached than that much of the crustal material native to North Africa has been literally transferred to Switzerland, where it is found to-day

in the sheared and flattened folds known as "Nappes." This implies a horizontal translation of about 500 miles. The solution of the problem of this very complex geological region is a triumph of the zeal and endurance of those scientists concerned, when we consider the dangerous surface and high altitude of the country traversed.



Reconstruction of the Map of the World for two periods according to the Displacement Theory. Lined: Ocean. Dotted: Shallow seas.
(*From Wegener.*)

Wegener assumes the continental areas (called "sial") to be portions of the crust of lower specific gravity than either the floor of the ocean or the stratum beneath the continents (or "sima"). He also assumes the sial to be in a state of flotation in the sima, and to be able to drift about in it given a sufficient amount of time. There is much controversy as to whether this very gradual movement is westward or eastward, Wegener supporting the westward drift argument, and being opposed by Joly and his followers. Wegener claims that Greenland at the present day is moving westward at the rate of 32 metres per annum! If this is a fact, modern accuracy of measurement of longitude aided by wireless should soon establish the truth.

Paleontology is the branch of science that both gives and receives most help in the discussion of this Continental Drift hypothesis. Many of the puzzles of the biologist can be solved if the actual continuity of continental masses could be proven in the Southern Hemisphere. Again, the general prevalence and thickness of the deposits of Radiolarian ooze in the Pacific points to a permanence of that ocean basin as contrasted with the Atlantic where this is relatively scanty. Another great argument for the former contact of the continents is the direction of the Trend lines of the folding of the crust. There is absolutely remarkable continuance of these if South America be fitted into Western Africa. Such a piecing together restores the lost "Atlantis." The vanished continent has not sunk beneath the sea. It has drifted apart and the newly filled Atlantic occupies the rift. Nor has this drifting finished. On the other margin of Africa, Wegener claims that Australia has broken away, and is to this day pushing up against New Guinea and crumpling rocks there as recent as Middle Miocene; the folds now are 15,000 feet high. Nowhere else have we such young rocks exhibiting such great movement.

Again, a study of rock structures supports the Drift Theory. The Nullagine conglomerates of W.A., with alluvial gold and diamonds, are duplicated exactly in the "banket" of the Rand, South Africa. Du Toit is absolutely convinced of the former union of South America and South Africa, witnessing as evidence the occurrence of Mesosaurus in the beds of Upper Dwyka formation and identically the same fossil reptile in South Brazil and Argentine. This is a pro-Wegener argument of much weight; it is somewhat discounted by the fact that no Mesosauri have yet been found in Australia.

An anti-Wegener argument is found in the occurrence of Helicoprion. This is a spiral saw-like arrangement from the jaw of an extinct shark, which must have been of a large size and a powerful swimmer. Helicoprion has been found north of Perth (W.A.), in Kashmir, in N.E. Russia, and in Japan. This presumes a large ocean for the shark where Wegener claims solid land. But Wegener is again supported by glacial evidence of the Permo-Carboniferous Ice Age. The trend of the drift of the Polar Ice would be simply radial from Antarctica if Wegener's Pan Gea of that epoch could be accepted.

Wegener's hypothesis is welcomed by botanists and zoologists. It explains also innumerable knotty problems of the geologist and others.

A Tribute to Professor Griffith Taylor.

(Continued from page 49.)

been an inveterate opponent of wild-cat schemes for the expenditure of vast sums of money, allegedly for the development of practically undevelopable areas, he has often been misunderstood. The practical man on the land, however, with a wide knowledge of Australia, finds that his experience and knowledge are in complete accord with the ascertained facts of this eminent geographer."

Professor Taylor will take with him to America our heartiest of good wishes and our affection, as well as the high esteem and admiration of a large number of the citizens of Australia. But, make no mistake, we must have him back again!

The Extraordinary Muggy Conditions at Sydney during the Summer 1927-1928

By D. J. MARES
(Divisional Meteorologist, N.S.W.).

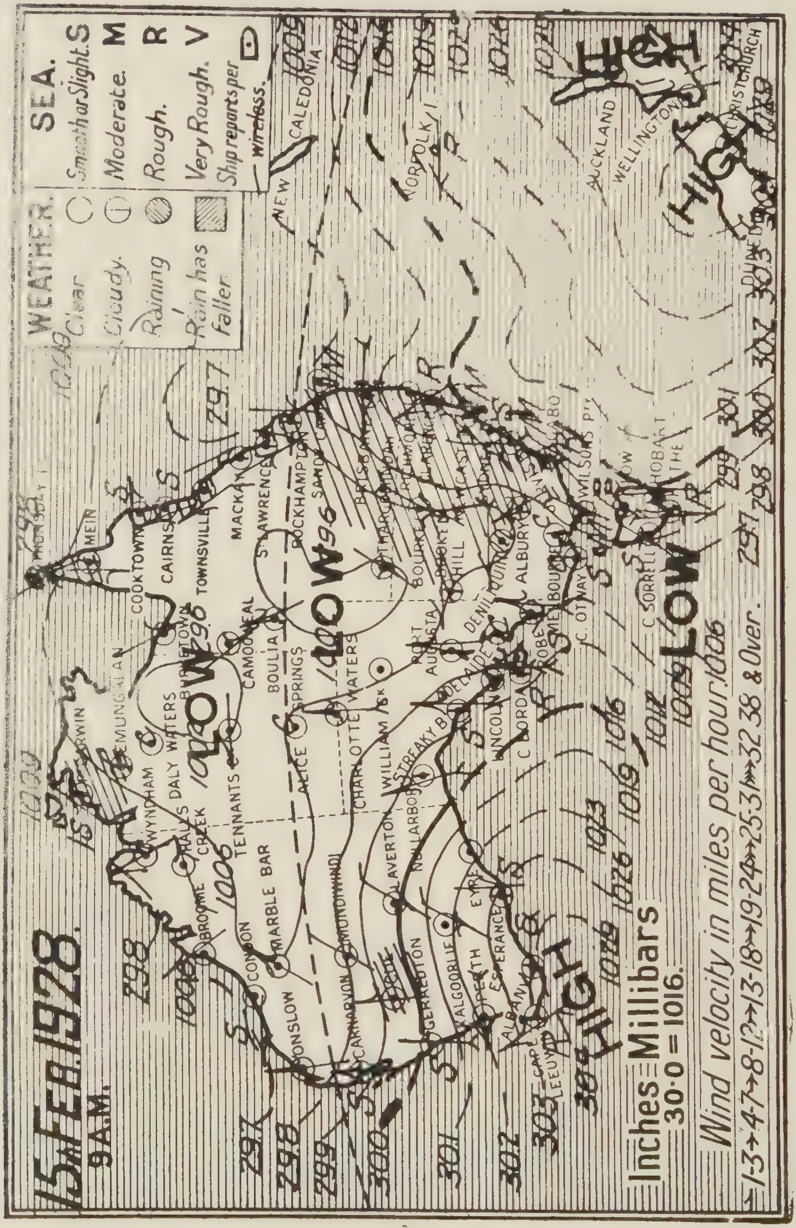
The summer of 1927-28, and the month of March, will long be remembered by Sydney people as a period of extreme mugginess. In many instances, the oppressiveness of the day was continued throughout the night, and, indeed, such conditions were so marked and sustained as to even strongly affect those who thought themselves immune from weather vagaries.

It is interesting to review the daily weather charts of the summer period and compare them with those which were associated with the pronounced droughty conditions that prevailed through many preceding months of the year 1927.

One of the chief characteristics of the prolonged dry weather is the relatively high barometric pressure which held sway over inland Australia while little or no inducement was given to rain-development, owing to the exclusion of any unsettled weather from passing depressions; the latter, even when in evidence, being either too far north or south, or, perhaps, moving too rapidly for the natural processes in rain production to mature. This kind of weather may be considered as one of two extreme phases.

A complete swing of the pendulum, as it were, is one of the chief requirements before we may expect a change to wet weather, or, as it is termed, "the break of the drought." Before this much-desired result can come into evidence, a considerable change must occur in the weather controls, or what might be looked upon as "the other extreme."

This change is brought into evidence by a general alteration in the distribution of atmospheric pressure, which must be of a type in which the relative situations of "Highs" and "Lows" (on the chart) are responsible for moisture-laden north or north-east winds from the tropical latitudes becoming an outstanding feature for several days at least, over the eastern half of Australia. Such conditions become possible when a big High pressure system lingers for some days over the South Pacific Ocean, and the eastern States of the Commonwealth. Over the latter region the student of weather maps and associated conditions cannot but be impressed with the persistence of east to northerly winds over that section of the mainland, and the increasing humdiity from day to day. Most often a tongue of low pressure, or even a closed-curve depression, develops over Central areas of Australia, and becomes more pronounced in character after the second or third day of appearance. This combination of high and tropical low pressure often results in some of the most definite rains in eastern parts of the continent; in which New South Wales largely participates.


15th Feb. 1928.
9 A.M.
WEATHER.
Clear
Cloudy.
Raining
Rain has fallen
SEA.
Smooth or Slight. S
Moderate. M
Rough. R
Very Rough. V
Ship reports per wireless.
Inches = Millibars
30·0 = 1016.
Wind velocity in miles per hour.
1-3 4-7 8-12 13-18 19-24 25-31 32-38 & Over.

The general conditions prior to the rain, attending the increase in atmospheric temperature and humidity, are what we are concerned with in the present discussion. In the summer months, some of the days are particularly muggy and oppressive due to the vaporous air, but in the past summer (and including March) there were such protracted periods of discomfort that one could easily imagine himself not dwelling in Sydney, but in some coastal town well within the tropics, and reasonably so, as illustrated by the average temperature and humidity figures for February, 1928.

Professor Griffith Taylor's *Australian Meteorology* in Fig. 27, page 295, presents a graphical illustration of typical climographs for Australia, based upon the wet-bulb temperatures, in which the values from 70 degrees to 75 degrees are (in his tentative discomfort scale) spoken of as usually uncomfortable. In the region where the latter conditions are most frequently in evidence, we find such places as Townsville, Darwin, Thursday Island and Hall's Creek. Extraordinarily enough, there is a very close comparison between those four places and Sydney for the month under discussion.

A glance at the accompanying table, giving the wet-bulb values of December, 1927, January, February and March, 1928, shows the relative frequency with which a wet-bulb temperature of 70 degrees and over occurred, more especially during February. In that month many readings of 70 degrees and over were experienced on successive days, and, on the whole, it is quite probable that no month in any year since 1859 (when observations were commenced at Sydney) was quite as humid or muggy as February, 1928. (See Table 1.)

Table 1 was prepared with the object of a comparison of the 1927-1928 summer with the average temperature and humidity conditions of the preceding eight summers. In this table the general experience in February is largely accounted for.

TABLE 1.

AVERAGES FOR YEARS 1919 TO 1927 INCLUSIVE

In brackets are the contrasted figures for similar information for the summer, 1927-28. Observations taken at 3 p.m.:—

	Wet Bulb Temperature.	Relative Humidity.
December	65.7 (65.5)	61% (64%)
January	67.0 (68.0)	62% (66%)
February	68.5 (70.5)	61% (73%)
March	66.0 (68.5)	62% (66%)

A favourite means in some quarters of illustrating the amount of vaporous air present is by determining the quantity in pounds or pints (if condensed) in a room.

Considered from this viewpoint, it is interesting to note the amounts of water present in the atmosphere of the average for the eight summers, 1919-1927, compared with the summer of 1927-1928; say the dimensions of the room were 15 x 15 x 10 feet, or 2,250 cub. feet.

Then the various quantities of water present in the atmosphere of the room would be as shown in Table 2:—

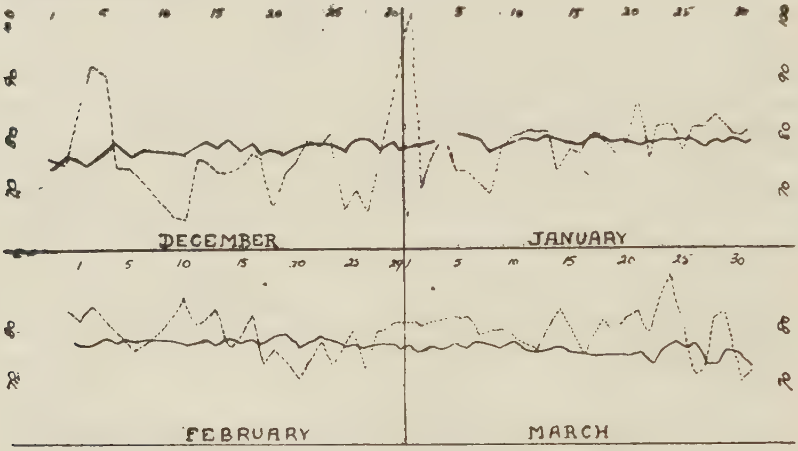
TABLE 2.

In a room of the dimensions 15 x 15 x 10 feet (2,250 cub. ft.), the following amounts of water in pounds give an idea of the comparative muggy conditions in the summer of 1927-28 and previous eight years:

	Lbs. per 2,250 cu. ft.
December	1.8 (1.8) observed at 3 p.m.
January	1.9 (2.0)
February	2.0 (2.3)
March	1.8 (2.0)

NOTE.—On 15th February, 1928, Mean of 9 a.m., 3 p.m. and 9 p.m., wet-bulb was 74.9°, or in the room 2,250 cub. ft., as much as 2.9 pounds of water present.

The accompanying graph shows a comparison of the daily maxima temperature in the period from 1st December, 1927, to 31st March, 1928, with the average.



A comparison of the Daily Maxima Temperatures during the period December, 1927, to March, 1928, with the *average* daily maxima temperatures for those months. The dotted line =, the daily maxima temperatures. The thick line =, the average maxima temperatures.

The weather chart which accompanies this paper is a copy of the one supplied to the *Sydney Morning Herald* on the 15th February, and is included because on that date the muggy conditions at Sydney attained its maximum. The weather in N.S.W. at 9 a.m. on the date in question was cloudy and unsettled throughout, and raining at places on the South Coast and Southern Tablelands, on the Central West Plains, and in Riverina and at a few places on the N.W. Slopes. During the previous 24 hours, light to heavy rain was recorded generally, but only light in Riverina, and scattered in the Far South-West; some very heavy falls occurred on parts of the South Coast, the North Coast, and on the Blue Mountains. The outstanding amounts were 770 points at Dorrigo and 646 points at Robertson. Such humid conditions attending the marked tropical activity so long in evidence synchronised with Sydney's period of greatest personal discomfort.

Some Aspects of the Aboriginal Problem in Australia [1]

These aspects are Political, Missionary and Cultural. Dr. Warner opened the discussion by the statement that *all* contact with our present civilisation is poison to the Australian aboriginal. The aboriginal has a well-understood code of community laws so finely constructed and balanced that any touch destroys that balance and carries destruction to the people themselves. The fundamental principle is an organisation based on *kinship* which has now lost all significance among ourselves. There are 70 different terms for degrees of relationship, and the white man on his advent can neither understand the system nor will amalgamate with it. But the white man has the dispensary power, so the black must adapt himself; he must abandon his whole religion and economic structure, and thereby he loses his personality and eventually his desire to live. Of conquered and earlier civilisations (for instance, the Pueblo American Indian), only those could survive who were so numerous that there were still some extant, and with sufficient vigour to graft themselves on to our civilisation, after the main bulk had succumbed to the *crush* of our advent. This the Australian has no hope of doing, but some effort must be made to make his passing easy. Two suggestions may be advanced: (a) The appointment of a Board or Department for Aboriginal Protection not in the hands of *politicians*, but entrusted to scientists, missionaries, and such as love the blackfellow; (b) the reservation of an area solely for blacks, say in eastern Arnhem Land, a soft, marshy country where there are no minerals and not much grazing. Here the aboriginal could continue many years undisturbed, and it would only be giving to him what actually belongs to him.

The Rev. F. W. Burton expressed pleasure at meeting those interested in the welfare of the aboriginal. There should be no friction or mutual jealousy between the missionary and the anthropologist. We must remember that the earliest missionaries often had too much power, and they overstepped even those limits. They were untrained in the significance of native customs, and so declared these customs to be absolutely wrong, and imposed their own civilisation on these primitive people. But we must also remember that they were pioneers, and had to grope their way, and naturally made mistakes. Now they admit that it has been ridiculous to insist on clothing, for example, and are much more ready to adapt themselves to native customs. The mistake has been that missionary zeal tried to bring about too sudden a change. For instance, in Fiji polygamy obtained for centuries; all social life was built upon it. The missionaries said

[1] Notes on addresses delivered to the Society, March 13, 1928, by Dr. W. Lloyd Warner, Professor A. R. Radcliffe Browne, and Rev. F. W. Burton.

it must stop. The chief must pick out one wife in his harem and turn the rest adrift, thereby doing untold harm.

Now that science, in the figure of the anthropologist, has come to the aid of the missionary, the latter would be entirely blameworthy if such a mistake were repeated. The old pioneers had no science to enlighten them. The missionary has three advantages over the anthropologist. He is more permanent; therefore, he can learn more of the language, and hence may obtain more of the trust of the natives. If also he has the trained powers of observation of the anthropologist, he can be a real help to science. Missionaries are charged with depopulating certain areas. The later census returns seem to deny this. When natives can survive the original shock, they are seen now on the increase in the best districts. We must admit that missionary enterprise will not *cease,* because it is rooted in a deep moral and altruistic instinct. But anthropology also will not cease. It also is founded on the truth instinct, and gives us a new appreciation of native customs and attitudes. And both fear the effect of commercialism, and that their work will be interfered with by folk whose object is either lust or gain. It is obvious that the anthropologist and the missionary must join forces.

The Australian aboriginals present perhaps the most difficult task to try and save, because of their nomadic habits. We cannot catch them. A dole pauperises them. It is a hardship to shut them up. We cannot put a ring fence around, for they will mix with the whites, and every contact is contamination to them. The hope of reconstruction is slender, but any reconstruction must be built on old foundations, and must use old material. Hence a nomad people can best be helped in a pastoral, and later in an agricultural, environment. Dr. Warner points out that only large numbers can withstand the shock of a new civilisation; that where a race is slender with a very delicately balanced culture and social law, the teachers must be specially well trained and equipped. But hitherto India and China, with their many millions, have received the best trained workers. Hence the missionaries are most anxious to enlist the sympathy of the anthropologist.

Professor Radcliffe Browne declares that the field of the ideal anthropologist, and that of the missionary, do not really touch. The work of the anthropologist is entirely objective. He treats the human native as the chemist does his substance, and thence draws conclusions. If he admits human sympathies and interests, he impairs the validity of his work. He then becomes a human being. The ideal anthropologist must not judge "this is good, or this is bad," he must only record and deduce. What is the likelihood of survival of the Australian aboriginal? Not 150 years ago, he owned and occupied this land. His primitive type of culture was in accordance with the scattered population and nomadic habits. There were property rights. Offenders would trespass, and there would be war. The death penalty to poachers was quite justifiable, for if stealing for food was permitted, then the owners must starve. The elaborate system of social life was based on kinship, each group owning certain territory. Even the deplorable and crude custom of infanticide can be justified as the less of two evils, where the abandonment of one of two children would ensure the

survival of the other when sustenance could not be found for both. Into this environment the white man comes. He takes the native's land, and so reduces him to starvation unless he undertakes to feed him.

This extermination of an interesting people is a most unsavoury fact. Is it necessary? Is it desirable? Can it be made more savoury Can we keep them alive to face a better career? The solution seems to be to keep the whites apart, and to help the blacks to survive as they are, with a very gradual modification. As to providing a Native State! This is regarded as hopelessly utopian and impossible. He discusses the work of the missionaries, citing the difficulties and results of many missionary enterprises. A zealous missionary will approach a tribe where no whites were before. Nomad tribes must wander, so the missionary must feed the natives to persuade them to stay. He works mainly among the children, and when these grow up they can no longer live as their fathers did, and support themselves in a desert environment. So they must starve or die out. This process entails an immense amount of effort with very little result. The Professor declares himself pessimistic as to the future of the aboriginals. The aboriginal is not inferior racially to many of our own people. Fifty per cent. are under-nourished. Their future is to have a little of aboriginal stock absorbed into whites of a little higher class. But the task of the anthropologist is to get knowledge, not to advise others as to what they should do. A relation such as that of the Pure Chemist to the Chemical Engineer is analogous to that of the Anthropologist and the Administrator.

The World's Food Supply

Is it likely to prove inadequate? [1]

The future of the world's food supply appears to be safe. There is one ultimate source of food, and one only, and that is green plant life. The cell tissue of these green plants can manufacture products beyond the scope of any living chemist. Plants require the presence of sunlight, air, water and certain soluble salts obtained from the soil. Consider the supply of these necessities. We need not fear a decrease in solar energy, nor a shortage of air. But the other two controls are by no means unlimited. Of the 33,000 million acres of land surface, we must eliminate areas that are too rugged, or desert, or snow-lands, and the result is an available 13,000 million acres for the production of plant food. It is obvious that if the population goes on increasing, the question arises as to how soon the food supply will give out.

The last century has seen the world's population roughly doubled, the remarkable increase being due partly to medical science, but more to the increase in food production, food preservation and food transportation. It can be said now that any man in a civilised country has the whole world for his farm. To-day the population increase is 1 per cent.

[1] Notes on an address delivered by Professor R. D. Watt, M.A., B.Sc. (Professor of Agriculture in the University of Sydney), May 8, 1928.

per annum, or 18 million people are added to the world's dinner table every year. At this rate, in 400 years, it would be necessary to make every acre of arable and desert land grow 15 bushels of grain and leave no space for fibre plants or pasturage. Dr. East, of Harvard, says the world would be saturated by 5,000 millions population, at a standard of living not nearly that of the present white race. And this figure may be looked for in about eight generations. Lord Rhondda declared in 1917 that all areas suitable for wheat were then in use. Sir William Crookes, in 1908, prophesied that 1931 would see the limit, when the food supply could satisfy the population. And in the conditions of production at that date (1908), the calculation was a reasonable one. The hope of the world is founded on the fact that the amount of the world's food supply is entirely altered by science.

The crux of the problem is the wheat yield. Present-day maps show that only three countries in Europe have any surplus, and this means importation from U.S.A., India, etc. India and Russia have a surplus only because their people do not get enough to eat. U.S.A. will not long continue to export. Canada is to be the source of wheat for Europe. Here science has done much. The world owes an immense debt to Saunders and his son for their introduction of a wheat that can be grown in high latitudes with a frost-bound winter. Canada has good soil and a large acreage, but a very short growing season. Frost attacked "Red Fife" wheat; Saunders crossed it with an Indian wheat that matures early, producing "Marquis" that ripens at least a week earlier than "Red Fife." This hybridization of a heavy yielding with an early ripening variety has been repeated successively into further and further northern regions, and the result is that up to 60°N. latitude can be used for wheat. This means that 400 million acres are available in Canada for wheat, yielding 20 bushels per acre, a total equal to one-third of the present consumption of the world.

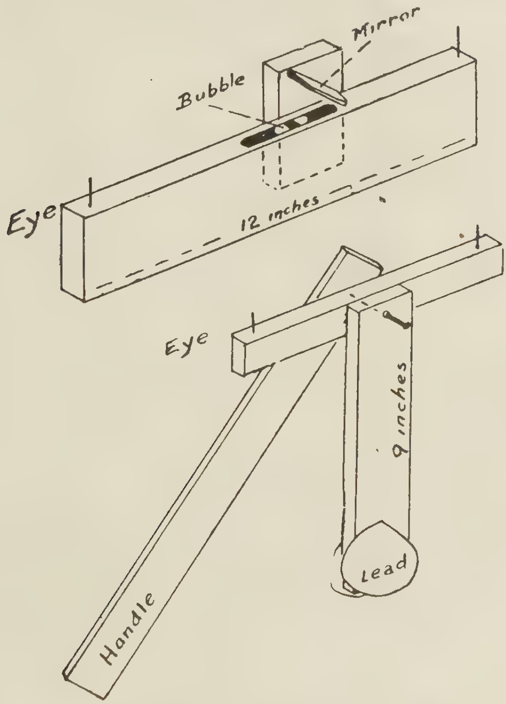
In Australia the problem is to find, not a frost-resisting, but a drought-resisting variety of wheat. Our disabilities are unreliable rainfall and hot, drying winds. It is not essential that all the necessary rain should fall during the period of growth of the wheat, for cultivation allows the farmer to preserve in the soil the rainfall of an earlier period. Science also instructs the farmer how to build up a richer soil by the addition of phosphates, and how to overcome prevalent diseases—stinking smut, flag smut, black rust and red rust—by hybridization with resistant varieties. So that the boundary which for years was the 10-inch isohyet is now on the arid side of that line, and 150 million acres are now available for wheat in Australia. If one-fifth were well cultivated, the yield would feed 30 million people in this continent.

Professor Watt concluded on a hopeful note. In the 400 years prognosticated as the limit in time for which the world can raise food for the population of that day, we may be blessed with new inventions not now conceived. We are in sight of an additional 100 million acres of virgin land; 30 years hence, science may render available another 100 million acres. It is reasonable to look for an increase of one bushel per acre every seven or eight years as the result of scientific breeding and cultivation.

Elementary Contouring

By GRIFFITH TAYLOR, D.Sc., B.E., B.A.
(Professor of Geography, University of Sydney).

Aims.—The study of many aspects of school geography is much helped if the pupils can make a simple compass-survey of the vicinity of their school, and a model of the same region. There should be no difficulty in making a map by means of a compass or plane-table. But the contour-lines (necessary for the model) are not added, usually because the school cannot afford to pay £3 for an aneroid. This brief article is written to show how approximate contours may be obtained at the cost of a few shillings at most. The method is satisfactory for a small region, say half a mile wide, with a contour difference of about 50 feet. It will enable the teacher to plot contours of five feet intervals, whereas the cheap aneroids will not serve for smaller intervals than 25 or 30 feet.



Apparatus.—Two forms have been devised—one is a primitive Abney Level, the other is an application of the pendulum. In both the object is merely to obtain a level line-of-sight in a rapid and convenient manner. For the Abney, purchase for three shillings a carpenter's level, preferably 10

or 12 inches long. Drive two pins into the level, as shown. It is well to have the bubble as far as possible from the pin nearest the eye, so as to see the bubble clearly. Fasten a thick piece of wood to the level, and cut on its nearer side a diagonal slot. In this slot insert a piece of mirror glass about one inch long. The observer places the Abney against his eye, looks along the level (below the mirror, which should not reach within quarter of an inch of the level) to the distant pin, and so to the desired position sighted. He can readily see the bubble swing back and forth across the cross-bar which bisects the bubble in most levels. He thus obtains a distant position *level with his eye.*

In the *swinging level,* the construction is obvious from the sketch. The nail passes loosely through the T-piece, and is fixed in the handle. The heavier the lead (or iron) attached, the sooner the level stops swinging. In the form used there are two lead plates, each about 2 x 2 x $\frac{1}{4}$-inch in size. However the handle is moved, the level-sighter will keep horizontal.

To adjust these two instruments in an approximate fashion, mark a spot on the wall in the school-room at the level of the pin near the observer's eye. Walk to the other end of the room and sight. Then adjust the other pin until it is in the line of sight from the near-pin to the mark on the wall. It is to be clearly noted that these instruments merely give contour-intervals at the height of the observer's eye. In most people this is nearly five feet, but with children the height of the eye (and, therefore, the interval) is smaller.

Practice.—A staff some ten feet long with feet marked upon it is to be carried by the assistant. The height of the observer's eye (X) and *double* that height (Y) are to be clearly marked on the staff.

Suppose we wish to add contours as we traverse *down* a steep road or slope. The observer stands at station A and sights along his instrument at the assistant. The latter walks down-hill until the observer sees the upper mark (Y) is at the level of his eye. The assistant halts and marks this spot with a stick or stone. The observer paces to this spot, which is obviously five feet (or one observer's height) lower, and notes the distance in his book. He then sights on the moving assistant until the latter again is five feet lower, and so on. If the corner of a block is not quite five feet below, it is quite easy for the two operators to find where the line of sight cuts the staff at some intermediate distance.

In traversing up hill, the assistant merely walks forward, and the observer waits till his feet are level with the line of sight. The assistant marks this spot and proceeds. The writer has tested this apparatus in the Mosman district, and the contours of a street-block $\frac{1}{4}$-mile long can be obtained in half an hour.

Simple Block Diagram Construction for School Children

By DOROTHY R. TAYLOR, B.Sc.
(Demonstrator in Geography, University of Sydney).

We presume that by some simple method a map of the district around the school has been made, and approximate contour lines plotted on it. Such a map is shown in Figure 1. The contour interval is 10 feet. Two tracks are plotted, and two converging streams are shown. The north arrow and horizontal scale must also be given.

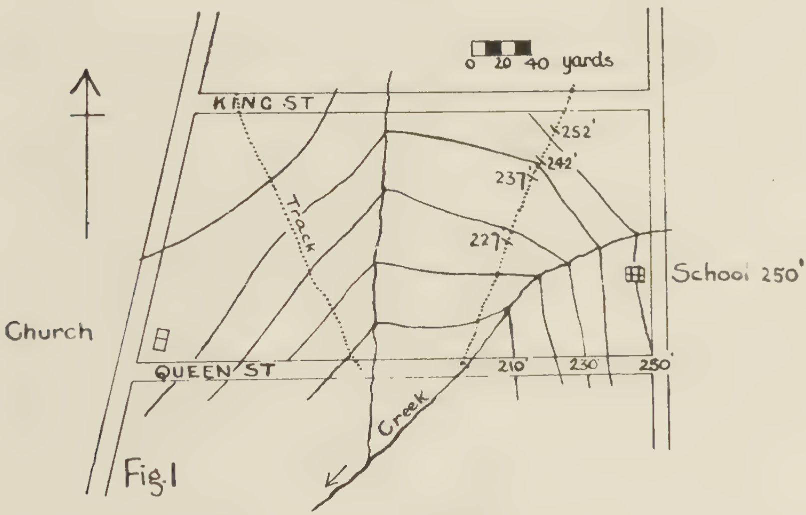


Fig. 1

We use the *isometric* (= "the same measurements") block, which disregards perspective, but has the advantage that the horizontal scale may be applied to the back (here the north) of the diagram as well as to the front (here the south). First a "skew-base" is drawn, with an angle of approximately 120° (Fig. 2). The aspect is a matter of choice, the easiest aspect to draw is such that the block rises in altitude from the front, backwards, so that here we have south at the bottom of the paper.

The creeks and tracks and contours and buildings (that is, all the features) are now sketched on the skew-base to conform with the skew.

The vertical scale is next selected. It will be found that those maps showing a small area with a very big scale (as here) need only be exaggerated vertically two or three or four times. Whereas, when large countries

or whole continents are to be depicted as block diagrams, where the horizontal scale is hundreds of miles to the inch, the vertical exaggeration is taken as fifty or sixty to one with advantage. These accompanying figures were originally constructed before reduction in the printing, with a vertical scale, 1 inch = 50 feet or .1 inch = 5 feet; and a horizontal scale 1 inch = 40 yards or .1 inch = 4 yards.

To find the exaggeration, bring both scales to a common number of actual yards or feet.

$$\text{Vertical (V)} = 60 \text{ feet} = 1.2 \text{ inch}$$
$$\text{Horizontal (H)} = 60 \text{ feet} = .5 \text{ inch}$$
$$\text{Then } \frac{V}{H} = \frac{12}{5},$$

or the vertical scale is nearly $2\frac{1}{2}$ times that of the horizontal. If no exaggeration of the vertical is allowed, the block is so flat that it is not possible to show any ordinary relief.

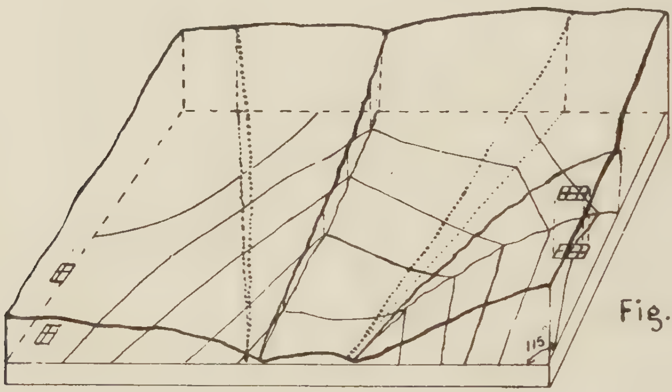


Fig. 2.

The elevation of the profile is next undertaken to the selected scale. On the margin of a piece of squared paper, ruled in 1/10 inches, tick off the vertical scale, here 2/10 for every ten feet. Then apply it to the edges of the skew-base, where each successive contour touches the edge. Mark on the paper the respective vertical distances, and join all these points with a heavy line. Next do the same where the contours cut the creeks or tracks. The school can be projected vertically also for the 50 feet it stands above the block base. The church must be estimated as between 40 feet and 50 feet up. Figure 2 shows, as through a transparent block, the original skew plan and the projected positions.

The easiest way to proceed to the shading and finishing of the block diagram is to trace off the top-layer of this now somewhat complicated set of lines, and to shade it suitably on the tracing, as shown on Figure 3.

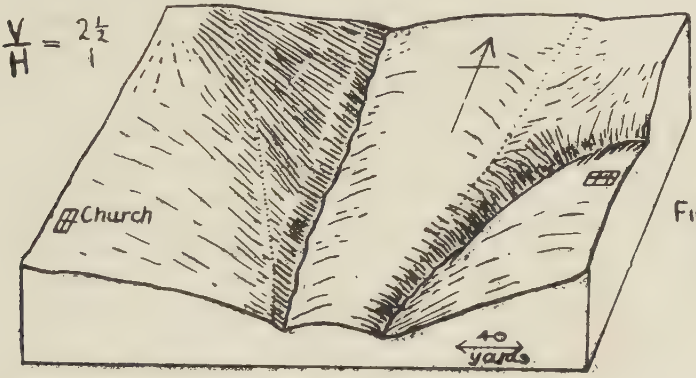


Fig. 3.

Note the north arrow is now best shown on the surface of the block itself, and it also partakes of the skewing; that is, the horizontal lines remain horizontal, as is the E.-W. line, but the N.-S. line must be shown parallel to the original road or side of the block in its new position.

The matter of shading is not easy. Two hints may be given: (1) Consider the block illuminated by a strong light from one direction, and so stress the lighted and shaded sides of hills and valleys; (2) imagine water dropping on to the block, and then draw the shade lines in the direction the water would flow.

If a more intricate diagram is attempted, the work is simplified by tracing off several successive stages as the line-work becomes more complicated.

Geography and the Child

By DR. MARIE BENTIVOGLIO

(Summary of Address given at the meeting in April, 1928.)

The position of geography in the high schools—where it does not enjoy the status of a full subject—is unsatisfactory. This disadvantage is reflected in the primary school student teacher who, before taking a course in the teaching of geography, must make good his knowledge of the subject. As geography is a living, and, therefore, ever-changing subject, the successful teacher must keep up to date, and for this is advised the reading of current books of travel, where interest makes the acquisition of information a delight.

It is customary for adults to study the geography of a region from its geology and topography, its climate and vegetation, finally deducing its economic and human development. But should this be the procedure adopted for children in schools up to the Intermediate standard? Such procedure is difficult for a child. It first requires the understanding and learning of much abstract information, so that by the time the pupil is prepared for the vital part of geography, *i.e.*, deducing the relation of man to his environment, his interest in the subject is too often stifled. Since to a child nothing is more concrete or of greater interest than children and people, surely there can be no sounder basis for the study of geography than the study of human geography. Whether it be the hunter, the fisherman, the desert trader, the mountaineer or the dweller of steppe or "black country," the study of people may be made the central theme in the regional geography course. The clothes, food, homes and occupations of a people (subjects of interest to a child) reflect the environment—the climate, the vegetation, the topography—of a region, and so from a sympathetic study of human geography sound inductions may be made to cover the whole field of geography. The two examples taken, the Kirghis and the Swiss, amply support the claims of human geography.

Attention is drawn to the fact that in Australia the study of human geography means the study of the aborigines, and not the super-imposed population of the last century. The human element could also be introduced with marked success in the study of our primary industries.

Geographical Progress in South Australia during the past two years

By DR. CHARLES FENNER

Although many of the geological papers prepared in South Australia during the past two years have devoted a few paragraphs to descriptions of physiographic features, there has been little geographical research accomplished during the period under review. The South Australian Branch of the Royal Geographical Society of Australasia, which is the chief body interested in geographical work, has devoted itself almost wholly in the past to historical matters and records of explorations. Later volumes of the society indicate a gradual movement in the direction of more truly geographical studies. Ethnological work is being actively conducted in this State at present, as recorded later by Dr. Campbell. Little has been accomplished in cartography, apart from Dr. Ward's new geological map of the State.

The paper entitled "Adelaide, South Australia: A Study in Human Geography" is fairly comprehensive in character. It summarizes the broad geological features in the Gulf Region and the Lake Torrens area to the north, and advances hypotheses regarding the structural movements in-

volved. The Adelaide Region and the nearer Mt. Lofty Ranges are dealt with in physiographic detail, with special attention to the influences of these factors on the rise and development of the city of Adelaide. The succession of block faults of the Mt. Lofty Ranges, the story of their differential uplift, the stripping off of the tertiary overmass, and the subsequent river development, take up a large part of the paper. Finally, spot maps of the population of the metropolitan area and of the Gulf Region are presented, with analyses of the occupations and recreations of the people, and these, in turn, are correlated with the prevailing physiographic and climatic conditions.

"The Plan of the Earth and its Origin" presents a fine summary of the chief contemporary views on these matters. The most valuable portion of the paper, from the local point of view, is the series of palæogeographic maps of Australia, particularly insofar as South, Central and North Australia are concerned.

It is a matter for much regret to South Australians that, since 1914, no further mapping has been carried out in South Australia. The Commonwealth Air Force has taken numerous aerial photographs that are of distinct geographical value, and these have been made available to educational bodies. The Education Department of the State has published a series of four geography text-books (The Adelaide Geographies) for their primary school classes. These are cheap and well illustrated; they should have a good influence on the geography teaching in the classes concerned. Mr. Grenfell Price has collaborated with Mr. Dudley Stamp in the production of a good general geography of the world for Australian schools.

The following are the chief publications of geographical interest during the past two years:—

Fenner, Chas.—*Adelaide, South Australia: A Study in Human Geography.* Proc. Roy. Soc. S.A., Vol. 51, p193.

Ward, L. K.—*The Plan of the Earth and its Origin.* Proc. Roy. Geog. Soc. of Aust. (S.A. Branch), Vol. 28, p171.

Howchin, W.—*The Geology of Victor Harbour, etc.* (dealing in part with exhumed pre-Permian landscape features). Proc. Roy. Soc. S.A., Vol. 50, p89.

Ward, L. K.—*A New Edition of the Geological Map of South Australia.* Notes in Annual Report, Director of Mines, 1928.

WEGENER AND A FISH.

Students of Wegener's hypothesis of drifting continents might find it worth while to study, amongst others, a fish, *Scleropages,* which, owing undoubtedly to the recent disconnection of the various portions of Malaysia (including New Guinea) and north-eastern Australia, has hardly had time to vary to any marked extent over the whole area. In the vast Malayan area its variation is quite slight. It is entirely a river fish, not able to cross sea areas.—D.G.S.

Recent Progress in Ethnology in South Australia

By DR. T. D. CAMPBELL

In 1926 the efforts of workers and those interested in anthropology in South Australia became very much strengthened and consolidated by two factors. Firstly, the formation of the Anthropological Society of South Australia; and secondly, the Council of the Adelaide University saw fit to give anthropology a definite status in that institution by creating a Board for Anthropological Research.

The society has among its corresponding members not a few enthusiasts who live in the "outback," and are continually in touch with the natives. The notes and answers to questionnaires which have been sent in by these members are gradually accumulating into a bulk of very valuable data.

Many of the members are keen on field work, and eight or more fresh occurrences of native rock paintings and four carvings have been brought to light by members since the society commenced activities; all of these, too, being within about fifty miles of Adelaide. The society is affiliated with the University, and holds its meetings monthly at the Anatomy School.

The Board for Anthropological Research was formed in order to stimulate, foster and control research in connection with the University. Since the fund for anthropological research has been made available in Australia by the Rockefeller Foundation, several grants have been made to University workers for field work. Field research in connection with the University has been carried out at Tarcoola, Ooldea, Macumba, Alice Springs, Swan Reach and Point Pearce. The work done has consisted of physical and physiological investigations, blood grouping, a study of native songs and music, and the taking of photographic cinematograph records.

Papers by the following have been published; almost all in the Proceedings of the Royal Society of South Australia, Vols. 50 and 51:—Sir Douglas Mawson, P. S. Hossfeld, N. B. Tindale, C. P. Mountford, R. Pulleine, T. D. Campbell, A. J. Lewis, H. L. Sheard, C. J. Hackett, J. B. Cleland, E. H. Davies, J. C. Jennison, W. A. Cawthorne.

"The Wonderland of North-West Australia"

By DOUGLAS STUART WYLIE [1]

The north-west of Australia, beyond Broome, is comparatively little known, except to pearlers and prospectors. With a view to investigating the possibilities of commercial development, I made a trip there during the winter of 1926. The first portion of the trip was made in the orthodox manner, *i.e.*, train from Sydney to Perth, and from there to

[1] Note on Cinematograph lecture given at meeting on October 14, 1927.

Broome by steamer. Several days were spent in Broome, whilst a trip was also made to Derby by air. At Broome a ketch of about 15 tons was chartered, and the necessary provisions obtained for an eight weeks' trip. Lines of all sizes and nets for fishing were also taken with us. From Broome we proceeded to the Lacepede Islands, about 80 miles north of Broome, and about 19 miles off the coast, where several days were spent fishing, catching and filming turtles, while a very fine male dugong was harpooned and caught. The latter was 10ft. 2ins. in length, 6ft. in girth at the widest part, and weighed just over 8cwt. Several sharks of an average length of 10ft. were caught; all being the "Tiger" variety.

After leaving the Lacepede Islands we visited the lighthouse at Cape Leveque, this light being the first seen by the regular vessels coming from Java to Western Australia, which make Derby the first port of call. Shortly after we left Cape Leveque we rounded Swan Point, and entered King Sound through Sunday Island passage. Here we had an unpleasant experience in the tide rips which are prevalent (owing to the tremendous currents which are caused by the extraordinary tides which prevail along the coast in that part of Australia). At Broome the steamer comes into the wharf, which is nearly a mile long, and ties up. This can only be done at high tide. The tide falls until the steamer is absolutely high and dry, the water receding far beyond the end of the wharf. Unfortunately, the tide changed before we made an anchorage, and there being little wind, we were carried out through the Sunday Island Passage to a point beyond Swan Point before we were able to make an anchorage. This sort of experience we had on several occasions at different points along the coast.

We spent a couple of days at Cygnet Bay in King Sound, and then crossed to the east side of King Sound and proceeded through Whirlpool Pass to Yampi Sound. Our passage through Whirlpool Pass was eventful. We had anchored for over a day at Steep Head, waiting for a wind. Eventually a light breeze sprang up, and our Captain decided to "give it a go." The Pass is three miles long, and "Z" shaped, and gets its name from the fact that it is one mass of whirlpools from start to finish. We had travelled barely a mile when the wind dropped, and we were left to the mercy of the currents. There was no anchorage, and no possible hope of turning back. On we went, turning round first one way and then another, until the last whirlpool was reached in the final bend of the Pass, just before Yampi Sound is reached. In this whirlpool we were carried round for over two hours, until finally the falling tide left us high and dry on the rocks. We lost many of our stores, and developed a nasty leak, but the boat was got off and brought out into Yampi Sound the following night. Most of us had gone ashore, and were camped in a little sandy bay round the point, and great was our delight when we saw the ketch slowly rounding the point in the middle of a beautiful moonlight night.

The country east of King Sound was quite different from that west of the Sound. Instead of the low sandy hills and plains, the country was

rugged and mountainous, with deep gorges and water courses. The coastline showed the country to be rich in minerals—iron ore particularly on Koolan and Cockatoo Islands, copper, silver and lead being frequently seen.

From Yampi Sound we proceeded into Collier Bay, and from there by easy stages, visiting numerous inlets en route, we came to Camden or Brecknock Harbour, a magnificent stretch of water dotted with a number of islands. Brecknock Harbour seemed to be swarming with fish, and we saw some mighty leaps, some being higher than the mast of the ketch. Turtles and dugongs also seemed numerous.

Augustus Water, an extension of Brecknock Harbour, was our next call, and there we stayed while some of the party journeyed to the Port George Mission a few miles inland. Mr. E. J. Stuart (of Perth) and I then proceeded on foot over the Macdonald Ranges, a few miles further in, to the plain between these hills and the Glenelg River. Apparently, there is a tract of about 100,000 acres of good grazing country here, and well watered. The rainfall at the Mission Station, I believe, runs to over 60 inches per annum. We proceeded round Augustus Island to the mouth of the Prince Regent River, and then down to Hall's Point, where we did considerable fishing, making good hauls of groper on the line, and mullet, white trevally and other fish, including flounder, with the net.

A call was made at the Montgomery Islands, which consist of two or three small rocky islands and one fair-sized island, formed by the mud from the Glenelg River on Coral. The latter island is the main island of the group, and is very low lying. It is covered with grassy flats and mangroves, and is infested with crocodiles.

We made some great catches of sharks at the Montgomery Islands, and also caught two dugong for meat. The natives on the Montgomery Islands, about ten in all, were a particularly well-built lot, and were quite the best I have seen anywhere in Australia. After leaving here we returned to Broome, calling at Koolan Island, and several other places en route.

After a few days in Broome we took steamer to Carnarvon, and then proceeded to Point Cloates, where a Norwegian company has established a whaling station. Here some six or seven hundred whales are caught and treated each year. Several days were spent at Point Cloates, and some excellent pictures were secured of the whaling. Another source of interest here was the large numbers of kangaroos which we saw in the district. Some evenings hundreds could be seen at one time.

My conclusions are that the North Kimberleys will never be an agricultural country, but that eventually large mining and fishing ventures will be developed along the coast. These must come eventually, but at the present time labour will be the great drawback to development.

A Brief Account of the Former Society

The Royal Geographical Society of Australasia: New South Wales Branch

By J. H. COLLINSON CLOSE, F.R.G.S.

This brief synopsis, culled chiefly from the archives, kindly placed at the writer's disposal, of the Royal Society of New South Wales, the Mitchell Library and the Public Library, Sydney, comprises odds and ends of general information abstracted from the proceedings, etc., of the erstwhile Geographical Society (N.S.W. Branch), arranged in approximate order of dates. These have been supplemented by what verbal particulars could be gleaned from the living reminiscent of the happenings of a quarter-century, and longer, ago.

A preliminary meeting of gentlemen interested in geography was held on 2nd April, 1883, at Dr. Belgrave's residence, when it was decided to form a new and distinct geographical body to replace the defunct Geographical Section of the Royal Society of New South Wales, and the Geographical Society of Australasia eventuated.

The personnel of the first Council and office-bearers was as follows:—Vice-President, Professor Stephens; General Council: Hon. P. G. King, M.L.C., Messrs. P. F. Adams and C. Rolleston; Hon. Secretary, Mons. E. Marin La Meslee; Hon. Treasurer, Mr. F. Gerard; Administrative Council: Messrs. E. Du Faur, F.R.G.S., Dr. Belgrave, Hon. W. A. Brodribb, F.R.G.S., G. Ranken, C. S. Wilkinson, Rev. J. Jefferis, LL.B.

The Inaugural Meeting, 22nd June, 1883, was attended by more than 700 persons. The Hon. Secretary read a paper upon "Past Exploration of New Guinea, and a Scheme for the Scientific Exploration of the Great Island." Later papers appear, illustrated with original drawings, upon the Australian aborigines, and upon a trip to Torres Straits and to south-east New Guinea, by Messrs. J. F. Mann and A. Morton respectively.

During the second Session, papers were read, as follows:—Explorations while Pearl-shelling in Torres Straits (R. Brew), Exploration through Arnhem Land (D. Lindsay), Borneo and Krakatoa (E. Cotteau), Exploration and Signalling by Captive Balloons (Dr. Belgrave), Notes on a Visit to New Guinea in H.M.S. *Nelson* (J. F. Mann), The Rivers of the Interior of New South Wales and their Treatment—with numerous appendical maps and plans (F. B. Gipps, C.E.).

An Australian Geographical Conference was held in the Town Hall, Melbourne, during December, 1884—Sir E. Strickland, K.C.B., F.R.G.S., President; Baron F. von Mueller, K.C.M.G., F.R.S., Vice-President. Among questions of major importance, the projected exploration of New Guinea predominated, perhaps, in discussion. This eventuated in 1885, in the expedition commanded by Captain H. C. Everill.

A "New Constitution for the N.S.W. Branch" was adopted at the General Annual Meeting, 17th June, 1886—the style then to be "The New South Wales Branch of the Geographical Society of Australasia"—about which time the names of Messrs. S. H. Myring and J. T. Cahill appear conjoined as the Hon. Secretaries. The Branch President, in his Annual Address for 1886-7, made reference to the accomplished survey in detail of Port Darwin, and to the improvement in charts of the trade route between Austrália and Hongkong, touching also upon general exploration and travel in eastern and central Asia, North and South America, and the Congo Free State. The Presidential Annual Address for 1888, although seemingly published, is not now available.

The "Journal and Proceedings," Vol. V. (for 1891-2) is, apparently, the next publication, incorporating a wealth of information embellished with many rare and curious maps and charts. There now regularly appears the prefix of "Royal" added to the society's name, His Excellency the Governor, the Earl of Jersey, P.C., G.C.M.G., becoming its Patron. The Council, having undergone changes, now included the Honorables G. H. Cox, J. Norton, LL.D., R. H. D. White (Ms.L.C.), Professor David, B.A., F.G.S. Edward C. Merewether, F.R.G.S., became the new President; the Vice-Presidents, Hon. P. G. King, M.L.C., F.R.G.S., Messrs. W. McMillan and F. B. Suttor (Ms.L.A.). Mr. H. S W Crummer assumed the Hon. Treasurership, the Hon. Secretaries now being Messrs. J. F. Mann and F. B. Gipps; also, later, G. Collingridge.

Among the matter embodied in Vol. V., Mr. E. Du Faur's article on Antarctic exploration, although somewhat brief, has a claim, in the light of subsequent events, to special attention; whilst the paper upon "Western Central Australia" (illustrated with a fine map) by the trans-Australian explorer, Mr. W. H. Tietkens, F.R.G.S., and that by Mr. G. Collingridge upon "Early Australian Discovery," with its profusion of old-time charts, teem with interest.

The society entertained Mr. (afterwards Sir) H. M. Stanley, the celebrated African explorer, at the Hotel Metropole, Sydney, on 4th December, 1891.

The Journal for January, 1896 (also headed Vol. VI., No. 1) gives papers upon The Source of Artesian Wells (F. B. Gipps), A Descriptive Vocabulary of the Native Language of Western Australia (The Very Rev. J. Brady, V.G.). The Journal for April, 1896 (Vol. VI., No. 2), contains "Notes on the Expedition of H.M.S. *Penguin* to the Funafuti Atoll," whilst the issue for July, 1896 (Vol. VI., No. 3), treats of portion of the Malay Archipelago (Captain F. B. Carpenter) and has an obituary notice of Baron F. von Mueller, the distinguished botanist. Vol. VI., No. 4 (for October-December, 1896), provides an account by R. Helms of "The Australian Alps or Snowy Mountains." There is also a Geographical Note on the Atoll of Funafuti by the late Mr. Charles Hedley, conchologist, and others.

In Vol. VI., No. 5 (January-March, 1897), the contributions include "Some Fragmentary Notes" upon Astrolabe Bay, New Guinea (by the late Baron Miklouho Maclay), Recollections of the Maclay Coast (A. Peck), Ascent of Mount Lindsay (P. W. Pears, M.A.).

In Vol. VI., No. 6 (December, 1898), the contents embrace Notes on the Solomon Islands (J. G. B. Nerdrum), and obituary notices of the intrepid Australian explorer, Ernest Giles, and of Commander Crawford Pasco, R.N., an officer on the Australian Naval Station who had usefully served geographical interests.

So far as has appeared, no further "Proceedings" were published by the R.G.S. of Australasia (N.S. Wales Branch), and with the passing of the old century, both public and private interest—in influential quarters, at least, rapidly waned. Its final manifest activity, 'tis said, was a Reception (supposedly financed by Mr. Crummer) accorded to the late Sir Ernest Shackleton—as yet unknighted—in the Lyceum Hall, Sydney, in April-May, 1909, when the famous explorer lectured upon the experiences of his British Antarctic Expedition of 1907-9—just then returned from the polar ice.

The Hon. Secretary, Mr. John F. Mann, having died in September, 1907, Mr. Crummer, it is understood, continued to rent, at his own charge, the society's (N.S.W. Branch) quarters in Bridge Street, Sydney, where its publications, exchanges and other belongings were housed until his demise, when over eighty, in August, 1921. With the death of this modest but "indefatigable worker in the interests of science and geography," Henry Samuel Walker Crummer, the New South Wales Branch of the Royal Geographical Society of Australasia ceased to exist.

SCOPE OF GEOGRAPHICAL RESEARCH.

Although the value of geographical enquiry and its vast scope have only been "discovered" by the mass in recent years, they have been long recognised by students. In this connection it is worth quoting some extracts from the *Transactions and Proceedings of the Royal Geographical Society of Australasia* (N.S.W. Branch), for 1885 and 1886, published in 1888. On pages 245-247 is a contributed article, "Aims of the Geographical Society," which is well worthy of the readers' perusal. The extracts are from that article:—

The science of geography is perhaps the most comprehensive of all sciences, not excluding even geology; for as geology, taken in its broadest sense, includes almost all other sciences, so geography includes geology itself. . . . . If a boy on leaving school has a smattering of names of principal countries, the heights of the biggest mountains, the length of the largest rivers, and some idea that the land is not quite so extensive as the sea, he is looked upon as quite an expert in this most despised of sciences, yet all his information is but of very little use, unless supplemented by a host of other details of which the schoolboy knows but little about. The science of geography, taken in its widest sense, treats of the geological formation, the physical features, the fauna, flora, and climate of the globe, including that immense watery waste into whose profound and sometimes fathomless depths we have even yet only succeeded in obtaining stray glimpses, at once mysterious and obscure, while it also deals with the political relations and past history of the great human race. History, therefore, dealing as it does with mankind in the past, as palaeontology does with former epochs of the globe, is also included within the spacious domain of this most comprehensive of all sciences. . . . . It would be difficult to overestimate the value of a

(Continued on page 88.)

GEOGRAPHICAL SOCIETY OF NEW SOUTH WALES

Report of the Council for the Year Ended 30th June, 1928
(Presented at the Annual Meeting in the Royal Colonial Institute on Tuesday, 10th July, 1928.)

The Council have much pleasure in presenting their first Annual Report.

PRESIDENT'S ADDRESS.—At the Annual Meeting the President delivered an address entitled "The Status of the Australian States," a study of fundamental geographical controls. It was illustrated by a number of lantern slides.

MEMBERSHIP.—The total membership on 30th June, 1927, was 127. Since that time 63 new members have been added, making a total of 190.

ACCOUNTS.—The Annual Statement of Income and Expenditure, together with the Balance-sheet, duly certified to by the Honorary Auditors, is included in the report.

INCOME AND EXPENDITURE ACCOUNT FOR YEAR ENDED 30th JUNE, 1928

EXPENDITURE.	£ s. d.	INCOME.	£ s. d.
To Printing and Stationery ..	14 16 11	By Subscriptions—	
„ Postages	15 3 11	163 Members at 10/- ..	81 10 0
„ Sundry Expenses	15 1 4	9 Members at 5/- ..	2 5 0
„ Excess Income over Expenditure	38 12 10		
	£83 15 0		£83 15 0

BALANCE-SHEET AS AT 30th JUNE, 1928

LIABILITIES.	£ s. d.	ASSETS.	£ s. d.
Subscriptions Paid in Advance for Years 1929 and 1930—		Cash at Commonwealth Bank	44 7 10
17 at 10/-	8 10 0	Subscriptions Outstanding ..	3 10 0
3 at 5/-	0 15 0		
Income and Expenditure A/c.	38 12 10		
	£47 17 10		£47 17 10

M. F. ALBERT, Hon. Treasurer.

I hereby certify that I have examined the Books and Vouchers of the Society, and that the above is a true and accurate statement of the Society's affairs as shown by the Books.

E. G. TROUTON, Hon. Auditor.

MEETINGS OF COUNCIL.—During the year two Preliminary Meetings, one General Meeting and nine Regular Meetings of the Council have been held. The attendance of members of Council at these meetings has been as follows:—

Professor Griffith Taylor, D.Sc., F.R.G.S. (President) ..	11
Professor W. R. Browne (Vice-President)	7
Professor L. A. Cotton (Vice-President)	3

The Hon. G. F. Earp, C.B., M.L.C. (Vice-President)	2
Miss D. R. Taylor (Vice-President)	10
Mr. M. F. Albert (Hon. Treasurer)	12
Dr. Marie Bentivoglio	9
Major Ernest Black, M.D., F.R.G.S. (Resigned June, 1928.)	8
Capt. F. J. Bayldon	7
Mr. Frederick Daniell	7
Mr. D. C. Ferguson [1] (Elected November, 1927.)	2
Mr. H. W. Hamilton	11
Professor John McLuckie (Resigned.)	0
Mr. D. J. Mares	4
Mr. A. L. Nairn	9
Capt. A. W. Pearse, F.R.G.S.	6
Mr. D. G. Stead	9
Rev. R. T. Wade (Resigned December, 1927.)	1

[1] Appointed a Councillor in place of the Hon. G. F. Earp, who was appointed a Vice-President.

LECTURES.—During the year the following series of lectures and addresses have been given before the Society in the Royal Colonial Institute and the University of Sydney. The attendance and general interest taken by members and the public have been most satisfactory.

The Council particularly desires to acknowledge the assistance of the Royal Colonial Institute and its Secretary (Mr. B. M. Mackenzie) in this connection.

August 10.—"The Aims of Modern Geography" (illustrated with lantern slides), by Professor Griffith Taylor, D.Sc., F.R.G.S.

September 14.—(a) "Nature's Own Time-Records," (b) "Geographical Apparatus and Methods" (illustrated by lantern slides), by Professor L. A. Cotton.

October 14.—"The Wonderland of North-West Australia" (cinematograph film), by Mr. Douglas Stuart Wylie.

November 10.—(1) "Distribution of Vegetation in the Sydney Region," by Mr. H. W. Hamilton; (2) "Physiography of the Illawarra Scarp, Stanwell Park Section," by Miss H. Brewster, B.Sc., and Miss A. Caldwell, B.Sc.

December 13.—"Northern Australian Aborigines" (illustrated with lantern slides), by Dr. W. Lloyd Warner.

February 14.—"Exploration of Rennell Island"; British Solomon Islands (illustrated with lantern slides), by Mr. G. A. V. Stanley, B.Sc.

March 13.—"Problems Concerning the Australian Aborigines," by Professor Radcliffe Brown, Dr. W. Lloyd Warner and the Rev. F. W. Burton.

April 12.—"Elementary Survey and Topography," by Dr. Marie Bentivoglio, Miss D. R. Taylor, Mr. A. MacInnes, and Professor Griffith Taylor, D.Sc., F.R.G.S.

May 8.—"The World's Food Supply: Is It Likely To Prove Inadequate?" (illustrated with lantern slides), by Professor R. D. Watt, M.A., B.Sc.

June 12.—"Drifting Continents"—The Wegener Hypothesis (illustrated with lantern slides), by Professor Sir Edgeworth David, K.B.E., C.M.G.

The Council especially wish to convey their sincere thanks to the several lecturers who delivered most instructive and interesting addresses during the year. The Council desires also to thank Sir Owen Cox and Mr. Frank Albert for their hospitality on the occasion of the first meeting.

Members are advised that a series of interesting and attractive lectures will be arranged for the current year. It is encouraging both to the lecturers and to members of the Society to know that many enquiries have been received in connection with the lectures delivered during the past year, while the subject matter on several occasions has led to valuable discussion in the press.

JOURNAL.—The first issue of a Journal, of some eighty pages, will be ready for distribution during the month of August. The Society is greatly indebted to the co-editors (Miss D. R. Taylor and Mr. David G. Stead) for their enthusiastic labours in this connection.

DONATIONS.—The Council have pleasure in recording their thanks to the following donors for gifts presented to the Society:—

Mr. M. F. Albert (Hon. Treasurer) for kindly offering to defray the expense of any blocks considered necessary for the Journal.

Capt. A. W. Pearse, F.R.G.S., for kindly offering to present to the Society any extra copies needed of the Journal.

The Hon. G. F. Earp, C.B., M.L.C., a valuable rainfall map of Australia.

Mr. H. W. Hamilton, Vol. 1 of the Proceedings of the Geographical Society of Australasia (1st Session, 1883-4), a valuable and rare edition.

MEMBERS' EXCURSION.—It was suggested by the President (Professor Griffith Taylor) that during the summer months arrangements should be made to hold an excursion for members of the Society to visit Broken Bay or some similar place of interest.

HONORARY MEMBERSHIP.—Honorary membership (for the currency of their stay in Sydney) was extended to Dr. James Park Thomson, C.B.E., Hon. General Secretary, Royal Geographical Society of Queensland, and Dr. R. K. Richardson, Principal Geologist for the Anglo-Persian Oil Co.

CONCLUSION.—The Council is gratified at the increase in membership during the present year, and hopes that the general interest taken by members in lectures and other activities of the Society will be maintained. While the steady growth in the numerical strength of the Society is most gratifying, the Council sincerely trust that members will endeavour at all times to increase the prestige of the Society by encouraging their friends to join. The subscription to the Society is exceedingly low compared with the many advantages offered to its members, which include a copy of the journal, *The Australian Geographer.*

On behalf of the Council,

GRIFFITH TAYLOR, President.

MARIE BENTIVOGLIO }
B. M. MACKENZIE } Hon. Secretaries.

GEOGRAPHICAL SOCIETY OF NEW SOUTH WALES

Constitution and Rules

1. NAME.—The Name shall be the Geographical Society of New South Wales.

2. HEADQUARTERS.—The Headquarters of the Society shall be situated at Sydney, in the State of New South Wales.

3. OBJECTS.—To promote and disseminate Geographical knowledge, with special reference to:—
   (a) Settlement and Trade. (b) Topography, Ethnology and Exploration.

4. MEETINGS.—(a) Ordinary Meetings shall be held monthly, or at such other times as the Council shall from time to time decide.
   (b) The Meetings shall be at the Lecture Hall of the Royal Colonial Institute, or in the Department of Geography, University of Sydney.
   (c) Each Member is entitled to bring one guest to these Meetings.

5. (a) The Annual General Meeting shall be held in Sydney not later than the end of September in each year.
   (b) Notice of this Meeting shall be given to Members, by letter with an agenda paper, at least fourteen days before the date fixed.

6. For the Annual General Meeting the Council shall prepare an Annual Report, which shall contain a list of office-bearers and Members. This shall be sent to Members at least fourteen days before the Meeting, with Nomination Forms for the election of President, Vice-Presidents and Councillors. These forms, duly filled in and signed, must be returned to reach the Secretaries at least seven days before the Meeting.

7. The business of the Annual General Meeting shall be: Consideration of the Council's Report and Balance Sheet. Election of President, four Vice-Presidents, and twelve Members of Council by Ballot. The business of which notice has been given in the agenda paper. Any other business of which at least seven days' notice in writing by a Member to the Secretaries has been given.

8. A Special General Meeting for any special business may be convened by the Council at any time, with the same notices as in the Annual General Meeting.

9. ALTERATION OF RULES.—(a) At the Annual General Meeting Members may move alterations of, or additions to, the Rules. Notice of any such motion must be given in writing to the Secretaries at least four weeks before the date of the Meeting.
   (b) The Council may draw up Rules between Annual General Meetings for confirmation by a Special General Meeting.

10. PROCEDURE.—(a) The President, or in his absence, a Vice-President, shall be Chairman at all meetings. In the absence of both, the meeting shall by vote elect a Chairman.
    (b) Voting shall be determined by a show of hands, and if the numbers are equal the motion or amendment put shall be declared not carried.
    (c) A motion that the question be not put, or a motion for adjournment, shall be put without discussion.

11. DEBATE.—(a) No discussion shall be allowed, except at ordinary Monthly Meetings, on any subject, unless seven days' notice has been given and the motion or amendment has been duly proposed and seconded; and no further amendment shall be discussed until one of the former has been decided.
    (b) No Member, other than the proposer in reply, shall speak more than once on any question before the chair, except to a point of order or in personal explanation, unless by special consent of the meeting.
    (c) The time for speeches shall be five minutes, unless otherwise decided by the Meeting.

12. In any case not provided for in these Rules, the Chairman shall decide in accordance with Parliamentary procedure.

13. Minutes of the proceedings at every Meeting shall be recorded in proper books kept for that purpose, and shall be signed by the Chairman of the Meeting at which they are confirmed.

14. MEMBERSHIP AND SUBSCRIPTIONS.—(a) New Members and Associate Members shall be nominated by two Members (one by personal knowledge) on the form provided, and shall be elected by the Council.
    (b) The Council shall have power to co-opt any other persons who by virtue of their scientific status shall be enrolled as Honorary Members.

15. The Annual Subscription shall be ten shillings, or such sum as the Council shall decide, for each year. University Undergraduates shall be eligible to become Associate Members at half such rates of subscription.

16. The financial year for subscriptions shall end on the thirtieth day of June in each year, and subscriptions for the ensuing year shall become due on the following day. If any Member or Associate Member fails to pay the subscription within one month, notice shall be sent by the Secretaries, and if the amount due be not paid within three months thereafter, such person, if the Council so decides, shall cease to be a member of the Society. The Council may, however, reinstate such person upon payment of all arrears.

17. COUNCIL.—(a) The Society shall be managed by a Council, consisting of: The President, the four Vice-Presidents, and twelve other Members selected by ballot at the Annual General Meeting, the Honorary Treasurer, the two Honorary Secretaries, and the two Editors.
    (b) These shall include: Three professional geographers (University teachers of geography) or meteorologists, surveyors or teachers of navigation, and three teachers of geography in High Schools or similar institutions.

18. The President, Vice-Presidents and other Members of Council elected at the Annual General Meeting shall assume office at the conclusion of that Meeting.

19. Any Member of the Council who ceases to be a Member of the Society, or fails to attend three consecutive meetings of the Council without reasonable excuse or leave having been granted, shall cease to be a Member of Council.

20. In the event of a vacancy in the Membership of the Council or in the office of President or Vice-President occurring between Annual General Meetings, such vacancy shall be filled by the Council by ballot.

21. Meetings of the Council shall be held monthly, or at such other times as Council shall decide. Seven Members shall constitute a quorum.

22. SECRETARIES AND TREASURER.—The two Honorary Secretaries and the Honorary Treasurer shall be appointed by the Council.

23. ACCOUNTS AND AUDIT.—(a) Proper books of account shall be kept by the Honorary Secretaries and the Honorary Treasurer. Accounts passed by the Council shall be paid by the Treasurer.
    (b) The financial year of the Society shall end on the thirtieth day of June, and the Annual Balance Sheet shall then be prepared by the Honorary Treasurer, and when certified by the Auditor, shall be presented to the next Meeting of the Council.
    (c) The Auditor shall be appointed by the Council, and shall have access to all books, vouchers, and accounts.

24. A Bank Account shall be opened in the name of the Society. Cheques drawn thereon shall be signed by two of the following Officers: The President, Treasurer and a Secretary.

25. JOURNAL.—(a) An Annual Journal shall be issued to all Members and Associate Members free. There may be one or more parts in the year.
    (b) The Editors shall be appointed by the Council.

Scope of Geographical Research.

(Continued from page 83.)

properly-conducted study of the natural and artificial products of this great Australian region and of its immense resources. Commerce is waiting to utilise the knowledge yet to be obtained, and a brighter future will dawn upon the colonies as soon as their vast natural resources are fully understood and properly utilised. The knowledge once gained can be diffused by means of illustrated lectures and publications. Then, the collection and publication of the records of the work and lives of the explorers, pioneers, and others identified with the discovery, formation or progress of Australia will also form a part of the task imposed upon the Society, together with the collection and preservation of ethnological and historical records of colonial interest, and, not least, of the manners and customs of those interesting savage races which so mysteriously vanish at the approach of civilisation and sometimes leave scarcely a trace behind.

GEOGRAPHICAL SOCIETY OF NEW SOUTH WALES

List of Members

Abbotsmith, F. A. .. .. Moree
Adams, Miss M. .. .. Teachers' College
Adamson, T. G. .. .. Mosman
Albert, M. F. .. .. Sydney
Austin, Miss M. E. H. .. .. Wahroonga
Anderson, Dr. C. .. Australian Museum
Baldwin, Miss N. .. .. Teachers' College
Bayldon, Capt. F. J., Royal Ex'ge, Sydney
Bentivoglio, Dr. M. .. University, Sydney
Bingham, J. .. .. Pennant Hills
Bishop, J. E. .. .. Sydney
Black, Dr. E. .. .. Edgecliff
Bowler, L. H. .. .. Dept. Lands, Sydney
Brewster, Miss H. E. W. .. Annandale
Brodie, F. T. .. .. Kensington
Brown, H. B. .. .. Rose Bay
Brown, Miss I. A. .. .. University, Sydney
Browne, Prof. W. R. .. University, Sydney
Brownhill, D. J. .. .. Sydney
Buckingham, Miss N. .. .. Cowra
Burrell, Miss D. .. .. .. Wentworthville
Burrell, Miss L. H. .. .. Wentworthville
Beresford, Miss P. .. .. Mosman
Brewster, Miss A. .. .. Annandale
Caldwell, Miss A. .. .. Singleton
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Castleman, A. W. .. .. Petersham
Challands, G. L. .. .. Rose Bay
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Clifton, Miss M. .. .. Homebush
Cohen, Rabbi F. L. .. .. .. Darlinghurst
Cook, Mrs. S. E. .. .. Mosman
Cooper, E. C. .. .. Chatswood
Costello, Miss D. .. .. .. Wahroonga
Cotton, Prof. L. A. .. University, Sydney
Cousins, G. W., Angus & Robertson, Sydney
Cox, Miss T. .. .. .. Teachers' College
Cox, Sir Owen .. .. Sydney
Craft, F. A. .. .. Ashbury
Craig, Prof. A. D. .. University, Sydney
Cunningham, Miss E. J. .. .. Chatswood
Cromack, Miss .. .. Cremorne
Clark, W. E. .. .. Epping
Close, J. H. C. .. .. Cremorne
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Dart, Miss D. .. .. Croydon
Dawson, T. W. .. .. Bellevue Hill
Dee, T. W. H. .. .. Canberra
Dellbridge, Mrs. M. .. .. Bellevue Hill
Denman, Miss O. .. .. Teachers' College
Deves, Miss T. .. .. Five Dock
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Dixson, W. .. .. Sydney
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Doyle, Miss C. M. .. .. Bexley
Dowsett, Miss E. D. .. .. Roseville
Drummond, Miss H. R. .. Neutral Bay
Dunbabin, T. .. .. Mosman
Dunbabin, Mrs. T. .. .. Mosman
Dunphy, M. J. .. .. Mortdale
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Glasson, Miss F. M. .. .. Killara
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Gilmour, Miss L. S. .. .. .. Chatswood
Graham, Miss V. .. .. Teachers' College
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Gallagher, Miss M. .. University, Sydney
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Hall, A. E. .. .. Balmain East
Hall, Miss L. .. .. Balmain East
Hamilton, H. W. .. .. University, Sydney
Hazelton, Miss J. .. .. University, Sydney
Henriques, Mrs. M. C. .. .. Cremorne
Henriques, Miss J. M. .. .. .. Cremorne
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Hill, E. McS. .. .. Wingham
Hinkel, Mrs. D. .. .. North Sydney
Hindmarsh, P. .. .. University, Sydney
Holman, Hon. W. A. .. .. .. Sydney
Hudson, E. T. .. .. Sydney
King, J. McE. .. .. University, Sydney
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King, Kelso .. .. Sydney
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Knowles, Dr. K. .. .. Sydney
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Lawson, Miss M. . . . . . . Marrickville
Legg, Miss E. . . . . Rockdale
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Livingstone, Miss A. . . . . Mittagong
Livingstone, W. F. . . . . . . Kensington
Lucas, L. E. . . . . Sydney
Lyons, W. J. . . . . Sydney
Macey, Miss R. . . . . Teachers' College
Macfie, H. C. . . . . Sydney
MacDonald, Miss N. . . . . Sydney
Mackaness, G. . . . . University, Sydney
Mackay, D. G. . . Port Hacking, N.S.W.
Mackenzie, B. M. . . 17 Bligh St., Sydney
Mackenzie, H. M. . . . . Sydney
Mackenzie, Miss F. . . . . . . Marrickville
Marchant, Miss D. H. . . . . . . Ashfield
Mares, D. J., Divis. Meteorologist, Sydney
Mathews, H. B. . . Dept. Lands, Sydney
McCarthy, V. C. . . . . Mosman
McGarry, Miss K. . . . . . . Hunter's Hill
McGrath, Lt.-Comm. B. J., Garden Island
McGrath, Lieut. P. S. . . . . Belmore
McLuckie, Prof. J. . . University, Sydney.
McMaster, F. D. . . . . Cassilis
Mullin, B. . . . . Sydney
Moore, F. H. . . . . Sydney
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McBride, J. . . . . Kogarah
MacInnes, A. R. . . . . Newtown
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Maclean, Miss D. . . . . Teachers' College
Middleton, Miss E. . . . . . . North Sydney
Moss, P. C. . . . . Canterbury
Moyes, Comdr. M. H. . . R.A.N., Sydney
Murray, Miss A. S. . . . . Cremorne
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Naylor, G. F. K. . . . . Ingleburn
Oliver, Miss E. H. . . . . Nowra
Osborne, G. D. . . . . University, Sydney
Palmer, Miss B. H. . . . . Manly
Parnell, Miss M. . . . . Teachers' College
Peake, F. J. . . . . Hurstville
Pearse, Capt. A. W. . . . . Sydney
Piggott, O. A. . . . . Vaucluse
Potts, C. V. . . . . Sydney
Powell, Miss D. K. . . . . Strathfield
Pye, E. . . . . Harris Park
Pink, Miss O. M. . . . . Pymble
Quodling, Miss F. M. . . University, Sydney
Raymond, Miss M. M. . . . . . . Cremorne
Rickard, Sir Arthur . . . . Sydney
Rickard, L. G. . . . . Naremburn
Ritchie, A. A., Angus & Robertson, Sydney
Rose, Miss J. . . . . Croydon
Roseby, Miss M. . . . . Cremorne
Ryan, Miss L. . . . . Arncliffe
Sargeant, F. A. . . . . Drummoyne
Sargeant, Miss R. A. I. . . . . Drummoyne
Saunders, Miss A. . . . . Edgecliff
Scot-Skirving, Dr. R. . . . . Sydney
Sharpe, Miss F. . . . . Epping
Shepherdson, Miss E. E. . . . . . . Lindfield
Slack, Miss E. M. . . . . . . North Sydney
Smith, H. Landon . . . . Sydney
Smith, Junr., Sydney . . . . Sydney
Smythe, F. T. . . . . Longueville
Soady, T. A. . . . . Potts Point
Spier, W. . . . . Sydney
Stanley, G. A. V. . . . . . . Port Moresby
Stanley, M. S. . . . . Sydney
Stanley, Miss H. V. . . . . Bondi
Stead, David G. . . . . . . Watson's Bay
Stephen, Miss D. . . . . Roseville
Stenhouse, Miss D. M. . . . . Miranda
Stewart, R. V. . . . . Chatswood
Sully, W. . . . . Vaucluse
Sulman, Sir John . . . . McMahon's Point
Sulman, Lady . . . . . . McMahon's Point
Sussmilch, C. A., Tech. College, Darl'hurst
Sutton, J. W. . . . . Kensington
Soul, Miss J. E. . . . . Strathfield
Taylor, A. S. . . . . Kogarah
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Taylor, Mrs. R. P. . . . . Chatswood
Taylor, Miss D. R. . . University, Sydney
Taylor, Prof. Griffith . . University, Sydney
Taylor, Mrs. Griffith . . . . Mosman
Taylor, Mrs. L. A. G. . . . . Mosman
Thompson, Miss D. . . . . Bondi
Tibbetts, Miss A. . . . . Teachers' College
Tilbrook, G. . . . . . . University, Sydney
Thorpe, W. W., Australian Museum, Sydney
Towle, C. C. . . . . Eastwood
Trouton, E. G. . . . . Elizabeth Bay
Tuckerman, Miss M. H. . . . . . . Ashfield
Tyler, C. F. . . . . Strathfield
Vindin, W. M. . . . . Sydney
Wade, Rev. R. T. . . . . Killara
Walker, Miss K. . . . . North Sydney
Waterhouse, L. L. . . University, Sydney
Waterhouse, W. L. . . University, Sydney
Watt, R. G.,
League of Nations Union, Sydney
Watts, Mrs. C. E. . . . . Artarmon
Whitham, Miss R. . . . . University, Sydney
Wilson, Miss L. . . . . Gosford
Wilson, L. G. . . . . Sydney
Wrigley, E. W. . . . . Gordon
Wylie, D. S. . . . . Sydney
Wymark, F., Angus & Robertson, Sydney
Wilson, Miss J. C. . . . . Arncliffe
Whittell, H. R. . . . . Pennant Hills
Wilkinson, T. L. . . . . Sydney
Wilshire, Miss O. . . . . Cremorne
Walter, E. L. . . . . Sydney
Watt, Miss P. E. . . . . Epping
Wilkinson, Miss J. . . . . Cremorne
Wilson, Miss C. G. . . . . Killara